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VOL. CXXXIII.—No. 3461] LONDON: FRIDAY EVENING, APRIL 28, 1922 [PRICE ONE SHILLING BY INLAND POST 1s. 3d.

PUBLIC NOTICES

The High Commissioner for India is prepared to receive TENDERS for the SUPPLY of :—

STEEL BOILER TUBES.

Forms of Tender may be obtained from the Director-General, India Store Department, Belvedere-road, Lambeth, S.E. 1, and Tenders are to be delivered at that office not later than Two o'clock p.m. on Tuesday, the 16th May, 1922.

T. RYAN,
Director-General.

9048

G. R.

BY DIRECTION OF THE DISPOSAL BOARD.

SOUTHAMPTON.

THE VALUABLE

FREEHOLD ROLLING MILLS,

Known as

GOVERNMENT ROLLING MILLS, SOUTHAMPTON,

Including certain PLANT

To be Sold (by Private Treaty).

SITUATION.—The property is situate in Weston-grove, close to the railway, tram and ferry, and adjacent to the River Itchen, in which is situate a jetty connected with the Factory.

AREA OF LAND.—About 52 acres.

BUILDINGS.—The main buildings are of substantial brick construction with Belfast truss roofs, and the property is equipped with the most modern Mills and auxiliary Plant and Machinery.

The principal buildings comprise :—

	Approx. floor area, ft. super.
Rolling Mills	124,200
Capping Shop	74,800
Foundry	74,800
Warehouse No. 1	19,900
Warehouse No. 2	11,200
Warehouse No. 3	12,200
Warehouse No. 4	19,900

TOTAL FLOOR AREA OF MILL ABOUT 337,200 FEET SUPER.

SIDINGS.—Private sidings are laid and arrangements might be made with the railway company for a connection.

POWER AND LIGHTING.—Electric, generated by plant on site.

HEATING.—High and low-pressure steam and hot air systems.

WATER.—From public main and stream.

Further particulars, plan and permits to view may be obtained on application to the CHIEF VALUER, Lands and Factories Section, Disposal Board, Room 2.6, Caxton House, Tothill-street, Westminster, S.W. 1. 8033

University College of Swansea.

APPLICATIONS are INVITED for the POST of LECTURER in CIVIL ENGINEERING. Salary £500 per annum. The appointment will date from October 1, 1922.

Further particulars may be obtained from the undersigned, by whom applications must be received on or before May 13, 1922.

EDWIN DREW,
Registrar.

Singleton Park, Swansea,
April, 1922. 7989

Aberdeen Corporation Electricity Works.

BOILER-HOUSE STEEL WORK.

The Town Council of Aberdeen are prepared to receive TENDERS for the SUPPLY, DELIVERY, and ERECTION of some 420 TONS of STRUCTURAL STEEL WORK, CORRUGATED IRON SHEETING, &c., forming a section of their new Boiler-house to be erected at Ferryhill Works, Aberdeen.

Specification, schedules of quantities, drawings, and form of Tender, &c., may be obtained from the City Electrical Engineer, Millburn-street, Aberdeen, on payment of a deposit of £2 2s., which will be refunded after receipt of a bona fide Tender and the return of the drawings and documents.

Extra copies of the specification and schedules may be obtained on payment of 10s. per copy, which will not be returnable.

Sealed Tenders, which must include the origin of the steel, endorsed "New Boiler-house," are to be addressed to the City Electrical Engineer and delivered at his office, Millburn-street, Aberdeen, not later than 22nd May, 1922.

NOTE.—Any tenderer for the above steel work, prepared to undertake also the plumber work and painter and glazier work required on the buildings, will be supplied with schedules for these sections on request.

J. ALEX. BELL,
City Electrical Engineer.

Electricity Department, Aberdeen,
30th April, 1922. 8057

East Indian Railway.

The Directors are prepared to receive up to Eleven o'clock a.m. on Wednesday, the 17th May proximo, TENDERS for the SUPPLY of—

GIRDER BRIDGES.

Copies of the specification can be obtained at the Company's offices on payment of £1 1s. each. This fee will not be returned.

G. E. LILLIE,
Secretary.

28/30, Nicholas-lane,
London, E.C. 4,
26th April, 1922. 8061

TO BRIDGE BUILDERS.

Stirling County Council Invite TENDERS for a STEEL SWING BRIDGE to carry road traffic over the Forth and Clyde Canal at Castlecary. The bridge to be manipulated by man power (two men), and to carry a live load of at least 30 tons over a span of 21ft., and to have a width between parapets of not less than 16ft. The offer to include Supplying and Erecting the Bridge, the Foundations for same, also Timber Dolphin, and everything necessary to hand over the bridge to the County Council in working order.

Further details may be obtained from Mr. Donald R. Cox, Road Surveyor, 48, Barnton-street, Stirling, and offers should be lodged with the Subscriber, Mr. James Learmonth, County Clerk, Stirling, on or before Monday, 15th May next.

The County Council do not bind themselves to accept the lowest or any offer.

JAMES LEARMONTH,
County Clerk.

County Buildings, Stirling
24th April, 1922. 8031

The Engineer

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Position Gauges and their Jigs.

The Fullagar Oil Engine for Land Purposes.

The Institution of Naval Architects.

Chinese Government Railways.

Recent Developments in Power Station Design.—No. XXVIII.

Turbine Reduction Gearing.

A French Petrol Locomotive.

Three Steps in Naval Construction.

A Rotary Pneumatic Motor.

PUBLIC NOTICES

London County Council.

TENDERS are INVITED for the SUPPLY and ERECTION of WROUGHT IRON BOUNDARY FENCING, &c., at The Chimes, Streatham Common, S.W.

Specifications and forms of Tender and contract may be had on application to the Chief Officer, Parks Department, New County Hall, Belvedere-road, Westminster, where the plans can be inspected. Tenders must be enclosed in the envelope provided and delivered at the County Hall, Spring-gardens, S.W., not later than 4 p.m. on Tuesday, 2nd May, 1922.

The Council does not bind itself to accept the lowest or any Tender.

JAMES BIRD,
Clerk of the London County Council.

8024

Port of Bristol.

GRAIN HANDLING MACHINERY, NEW GRANARY, ROYAL EDWARD DOCK, AVONMOUTH.

The Docks Committee are prepared to receive TENDERS for the CONSTRUCTION and ERECTION on site of GRAIN HANDLING MACHINERY for the New Granary, Royal Edward Dock, Avonmouth. The machinery consists of Elevators and Conveyors and includes Motors and Switchgear for driving the same.

On and after Friday, the 28th April, 1922, copies of the specification and contract drawings can be obtained from the undersigned on production of a receipt showing that a deposit of £3 has been paid. All cheques must be made payable to "The Bristol Docks Committee" and forwarded to the General Manager and Secretary, Dock Office, 19, Queen-square, Bristol. The deposit will be returned to bona fide tenderers after the receipt of the Tender with all the prescribed documents and drawings.

Tenders must be enclosed in a sealed envelope, endorsed "Tender for Grain Handling Machinery," and addressed to the General Manager and Secretary of the Docks Committee, 19, Queen-square, Bristol, and must be delivered to him, accompanied by all the prescribed documents and drawings, before 10 a.m. on Tuesday, the 23rd May, 1922.

The Docks Committee do not bind themselves to accept the lowest or any Tender.

THOMAS A. PEACE,
Engineer.

Engineer's Office,
Avonmouth Docks,
20th April, 1922. 7984

City of Bradford.

CHIEF ASSISTANT ELECTRICAL ENGINEER.

APPLICATIONS are INVITED for the POST of CHIEF ASSISTANT ELECTRICAL ENGINEER in the Electricity Department of the Bradford Corporation.

The person appointed is required to assist the City Electrical Engineer and Manager in all engineering matters, but principally in connection with the generation and distribution of electrical energy.

Applicants must have received a sound technical education and have practical knowledge of the design and operation of electrical generating and converting plant and transmission and distribution systems.

The salary attached to the post is £725 per annum.

The successful candidate will be required to devote his whole time to the duties of the office and to reside within the city.

Canvassing members of the Council will be a disqualification.

Lists of duties and forms, on which applications are to be made, may be obtained from Mr. Thomas Boles, City Electrical Engineer and Manager, Town Hall, Bradford.

Applications, endorsed "Chief Assistant Electrical Engineer," accompanied by copies of not more than three testimonials (which will not be returned), to be sent in time to reach me not later than the first post on Thursday, 11th May, 1922.

N. L. FLEMING,
Town Clerk.

Town Hall, Bradford.
25th April, 1922. 8044

PUBLIC NOTICES

South African Railways and Harbours.

ELECTRIFICATION OF GLENCOE-PIETERMARITZBURG SECTION.

TENDERS are invited for STEEL-FRAME BUILDINGS for Power Station.

Specifications and Forms of Tender may be obtained at the Office of the High Commissioner for the Union of South Africa, Trafalgar-square, W.C. 2, on and after the 28th April, 1922.

The Consulting Engineers, to whom applications for further technical information may be made, are Messrs. Merz and McLellan, 32, Victoria-street, London, S.W. 1.

The charge for each specification is Five Guineas for the first copy, and Two Guineas each for any further copies. Sums paid for any number of specifications up to three will be refunded on receipt of bona fide Tenders. Sums paid for copies of the specification beyond three will not be refunded.

Sealed Tenders, marked "Tender C 932," are to be addressed to THE SECRETARY, Office of the High Commissioner for the Union of South Africa, and lodged at the above address not later than noon on 29th June, 1922.

The South African Railways Administration does not bind itself to accept the lowest or any Tender. 8057

AN EXCEPTIONAL "BUSINESS OPPORTUNITY."

TAKE THE LONG VIEW FOR TRADE REVIVAL.

For Sale as a Going Concern, one of the most complete and best equipped

ENGINEERING WORKS

in the South of England, recently valued at over £130,000.

Some proportion of the purchase money would be allowed to remain on mortgage, provided vendor is satisfied that adequate working capital will be provided.

Principals only address 8029, The Engineer Office. 8029

WANTED by a Port Authority, a Fully Qualified CHIEF DRAUGHTSMAN in the Chief Engineer's Office, age about 35/40 years. Salary £700 per annum. Applicants should state fully their experience in designing and construction of docks, buildings, constructional steel work, bridges, reinforced concrete, surveying and quantity surveying, also if disengaged or how soon they could take up duty. Applicants should be competent take control of drawing-office staff and should state fully their experience accompanied by references.—Address, 7995, The Engineer Office. 7995 A

PUBLIC NOTICES

The Great Indian Peninsula Railway Company.

The Directors are prepared to receive TENDERS for the SUPPLY of the following STORES, namely :—

No.		For Specification,
1.	MILD STEEL BARS, &c.	£1
2.	STRAIGHT AXLES (Forgings) for ENGINES and TENDERS	5s.
3.	BOLTS, NUTS, RIVETS, &c.	£1
4.	ROLLED STEEL DISC WHEELS	7s. 6d.
5.	ACID OPEN-HEARTH STEEL BOILER PLATES	5s.
6.	ANVILS	2s. 6d.
7.	JIM CROWS	2s. 6d.
8.	CANVAS HOSE PIPES	5s.
9.	LEATHER BELTING, &c.	10s.
10.	STATION BELLS, BIBCOCKS, &c.	5s.
11.	PLATELAYERS' TOOLS	10s.
12.	WOOD HANDLES	10s.

Specifications and forms of Tender may be obtained at this office on payment of the fee for the specification, which payment will not be returned.

The fee should accompany any application by post. Cheques and postal orders should be crossed and made payable to the Great Indian Peninsula Railway Company.

Tenders must be delivered in separate envelopes, sealed and addressed to the undersigned, marked "Tender for Mild Steel Bars, &c.," or as the case may be, not later than Eleven o'clock a.m., on Tuesday, the 9th May, 1922.

The Directors do not bind themselves to accept the lowest or any Tender.

R. H. WALPOLE,
Secretary.

Company's Offices,
48, Copthall-avenue, E.C. 2,
London, 26th April, 1922. 8062

London County Council.

SKILLED MECHANIC WANTED for General Repairs and Upkeep of Running Gear and Machine Tools in Metal Work Centres. Man trained as fitter, turner and machine tool maker or general millwright preferred. Rate of pay is appropriate prevailing trade rate for engineering trades (mechanical), and a special sum of 10s a week (current rate) will be allowed in addition.

Apply to Education Officer (E. 24), New County Hall, S.E. 1 (enclosing stamped addressed foolscap envelope), for form of particulars, to be returned by 6th May, 1922. Preference will be given to men who have served or attempted to serve with H.M. Forces. Canvassing disqualifies.

JAMES BIRD,
Clerk of the London County Council.

8023

SITUATIONS OPEN

WANTED, First-class BOILER INSPECTOR, for large company having collieries, iron and steel works. Please give full particulars of training, qualifications, experience, and salary required.—Address, 8043, The Engineer Office. 8043 A

WANTED, First-class DESIGNER, Experienced in Designing and Developing Small Machines. Must have originality and be thoroughly practical. State age and salary required. London district.—Address, P5297, The Engineer Office. P5297 A

WANTED IMMEDIATELY, a MECHANICAL DRAUGHTSMAN, with experience in Waterworks and Vertical Pumping Engines. Six months' engagement. Apply, stating qualifications and salary required.—Address, J. C. BOWLEY, Engineer, Eastbourne Waterworks Company, 28, Seaside-road, Eastbourne. 8009 A

WANTED, WORKS MANAGER, by an Old-established firm of manufacturers who specialise in Railway Track Requisites and in Bridge Building. Only man possessing sound knowledge of economical design and of modern shop management need apply.—Box 6259, c/o Brown's, 89, Tothill-street, S.W. 1. 8020 A

A VACANCY OCCURS for a First-class SALES REPRESENTATIVE for the following territories :—(1) South Wales, (2) Lancashire and North Wales, (3) Yorkshire and South of Tweed, (4) Scotland, (5) Nottinghamshire and Midland Counties, (6) Ireland. Applicants must be first-class Engineers and Salesmen, accustomed to handling all kinds of new and second-hand machinery. Must be prepared to take up a nominal holding in the company. Only live men need apply.—Address, 8006, The Engineer Office. 8006 A

A WELL-KNOWN MOTOR CAR FIRM REQUIRES the SERVICES of a General MACHINE SHOP SUPERINTENDENT.—Address, giving age, salary required, and full details of experience, stating with what firms same has been gained and giving dates, 8007, The Engineer Office. 8007 A

ACCOUNTANT REQUIRED for West Africa. Age not over 26. Thorough knowledge accounts. Capable of installing and supervising complete system of steamers' running accounts and cost accounts for engineering and repair work.—Address, stating age, previous experience, and salary desired, P5246, The Engineer Office. P5246 A

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SITUATIONS OPEN (continued)

COAL HANDLING.—REQUIRED, Competent ENGINEER, of French nationality, with knowledge of Electric Transporters, Generating Plant and Coal Screening, to Take Charge of Small Installation at Rouen. Able to handle labour and speak English.—Address, P5292, The Engineer Office. P5292 A

CONTROL APPARATUS DESIGNER.—Experienced MAN REQUIRED, capable of working out designs of Traction Control Apparatus from a specification with scheme of connections; experience of modern locomotive control gear essential; knowledge of manufacturing methods an advantage; must be good disciplinarian. State age, technical training, experience, and salary required.—Address, 7967, The Engineer Office. 7967 A

ENGINEER, with Extensive Knowledge of Storage and Handling of Grain, Must have had experience in planning and carrying out large contracts. Knowledge of foreign requirements essential. Experienced in negotiating important business abroad. Liberal salary and good prospects.—Box 580, Advertising Offices, 84, Queen Victoria-street, London, E.C. 4. 8025 A

REPRESENTATIVE, with Established Office, REQUIRED by leading London Firm of Reinforced Concrete Designers and Contractors, with important exclusive specialities, for the North-West, South-West, and Midland districts. Applicants must be conversant with this class of work and should furnish full particulars of experience and connection. Terms on commission basis.
Write, Box 842, Dorland Agency, Ltd., 10, Regent-street, S.W. 1. P5278 A

WORKS MANAGER.—WANTED by a Large Structural Engineering Firm, an ASSISTANT MANAGER, with thoroughly good general and technical education and with specialised knowledge and experience of Bridge, Structural and General Design. He must also have had experience in works organisation and in the preparation of estimates and tenders.
The appointment offers good opportunities to the man who combines with the above qualifications initiative and tact. Salary, which should be stated, will be according to qualifications.
Address, P5294, The Engineer Office. P5294 A

FIRST ASST. DRAUGHTSMAN WANTED for works, E. London; able to take out own quantities, capable of supervising work; must be energetic, thoroughly accustomed with boilers, jacketed pans, stills, buoys, tanks, and all kinds of pressure work.—Address, stating age, wages required, and full experience, 8037, The Engineer Office. 8037 A

REQUIRED by a European Firm of Structural and General Engineers in India, an ASSISTANT FOREMAN in their Structural Department. Applicants must have experience in Template Making and be accustomed to Bridge, Roof and General Structural Work. Must be a bachelor and not more than 26 years of age.—Reply, giving particulars of experience, Z. X. 472, care Deacon's, Leadenhall-street, E.C. 3. 8027 A

WANTED, a WORKING MILLWRIGHT, for the Maintenance of Steam and Gas Engines, used to Electric Revolving Motors and Controllers, good fitter and turner, one used to Electric Cranes and Gasworks Plant. State wages; references required.—Address, 8058, The Engineer Office. 8058 A

SITUATIONS WANTED

A CARRIAGE and WAGON ENGINEER (37) SEEKS RE-ENGAGEMENT about month's time. Position as assistant works manager, superintendent, or of administration, estimating, buying, design, production, inspection, home or abroad.—Address, P5293, The Engineer Office. P5293 B

A POWER STATION ENGINEER, with Experience in construction, operation and maintenance of steam turbines and reciprocating engines with all auxiliary plant and boilers, good theoretical and practical knowledge of station economy, experience in manufacture, operation and maintenance of E.H.T. generators, transformers and switchgear, &c., good knowledge of electrical specifications and buy-best of plant, DESIRES POST as Electric Power and Maintenance Engineer with engineering firm of iron and steel works; age 32, married.—Address, P5287, The Engineer Office. P5287 B

ADVERTISER (Age 36), 22 Years' Experience of marine, motor, and general engineering, 5 years foundry manager, 5 years foreman patternmaker, is OPEN for ENGAGEMENT in any capacity where tact, energy, and ability are required. Good references.—Address, P5254, The Engineer Office. P5254 B

ADVERTISER (44) DESIRES POSITION of Trust with engineering firm. Lifelong experience gained by hard work, embracing costs and estimates, correspondence, overhead charges, accountancy, technical problems, calculations and graphs; good mathematician.—Address, P5310, The Engineer Office. P5310 B

BUYER.—The MANAGER of a Large Engineering Works Purchasing Dept., who has an exceptionally wide knowledge of the markets of the country, DESIRES to NEGOTIATE NEW APPOINTMENT.—Write, Z. M. 613, c/o Deacon's, Leadenhall-st., E.C. 7908 B

CAN ANY ENGINEER HELP?—ADVERTISER (32), B.Sc., A.M.I.E.E., married, 11 years' practical experience, constructional and maintenance, used to big jobs, will ACCEPT any reasonable OFFER. Position serious.—Address, P5282, The Engineer Office. P5282 B

ENGINEER, A.M.I.M.E., M.I.A.E., &c., with London office, is OPEN to REPRESENT MANUFACTURERS or act as English Agent for continental firms engaged in engineering and allied trades or specialities. Inquiries invited.—Write, WILLIAM COPSEY, 4, Devonshire-chambers, 146, Bishopsgate, London, E.C. 2. P5275 B

ENGINEER, Certified, Well Experienced with steam, electrical, hydraulic, refrigerating, gas, oil machinery, and boilers, workshops, steady man, WILLING to TAKE any JOB. Moderate salary if permanent employment. Excellent references.—Address, P5279, The Engineer Office. P5279 B

ENGINEER (27) DESIRES POSITION as Assistant; 3 years railway works, 1 year D.O., 1 year steel structural design, 1½ years office training for A.M.I.C.E.—Address, P5324, The Engineer Office. P5324 B

ENGINEER-DESIGNER (35), 18 Years' Exp. labour-saving machinery and devices, automa. glass mach., steam-electric, compressed air, is OPEN for ENGAGEMENT.—Address, P5321, The Engineer Office. P5321 B

ENGINEER, Exceptional Experience, 1st Class B.O.T. certificate, A.M.I. Mech. E., present manager of general engineering works (closing down), up-to-date shop management, energetic, tactful handling men; late consulting and works engineer the largest railway carriage and wagon works in United Kingdom; previous assistant to consulting engineer on hotels, institutions, &c. Salary required £500 to £600, with prospects.—Address, 8055, The Engineer Office. 8055 B

SITUATIONS WANTED (continued)

ENGINEER, G.I. Mech. E. (25), 2 Yrs. Tech., 4 Yrs. shops, 3 yrs. D.O., SEEKS SITUATION, Re agencies.—28, Ashdown-road, Kingston-on-Thames. P5284 B

ENGINEER and DRAUGHTSMAN, 30 Years' Experience general, marine, automobile and constructional steel work, also by-products and coke oven plants, SEEKS POSITION.—H., 29, Werter-road, Putney, London. P5289 B

ENGINEER REQUIRES POST as ASST. MANAGER or REPRESENTATIVE in Engineer's Office in London. Highest personal and technical qualifications and experience. Able correspondent and organiser.—Address, P5306, The Engineer Office. P5306 B

ENGINEER (34), 20 Years' Experience General Engineering, tool-room, millwrighting, present sit. 7 years, would LIKE new ENGAGEMENT as Works Engineer.—Address, P5285, The Engineer Office. P5285 B

ENGINEER, 20 Years' Experience, Willing to become SALES ENGINEER or TRAVELLER for an engineering firm; well up tools, jigs, millwrighting gear, and oil engines.—Address, P5286, The Engineer Office. P5286 B

MANAGER of 16 Years' Experience, with Public school and technical training, M.I.A.E., A.M.I.M.E., A.M.I.E.E., good disciplinarian and salesman with good connection, sound knowledge of marine, motor, and hydraulic engineering, chemistry, &c., secretarial work, office and works management, highest references and testimonials, SEEKS POSITION as Manager or Representative, in or near London preferred.—W. F. D., Lensdene, Hanwell, W. 7. P5299 B

MECHANICAL ENGINEER, with Good Practical general experience as foreman, cost clerk and manager, NEEDS responsible POST in any capacity, any district.—SNOAD, 36, York-road, Hitchin. P5300 B

MECHANICAL ENGINEER, with First-class Qualifications and experience, is OPEN to CONSIDER OFFER of responsible APPOINTMENT at home or abroad, where ability and experience count.

A.M.I. Mech. E., M.I. Loco. E.

Over seven years' experience in locomotive department and drawing-office of English railway.

Eight years' experience as inspecting engineer for consulting engineers; engineering and railway material, locomotives, railway carriages and wagons, during construction at makers' works for foreign and colonial railways.

Four years technical officer, Air services, organised offices, training staff of inspectors, assisting to compile specifications, inspecting aero-engine parts, steels and materials, Instruction officer, aero-engines, to R.A.F.; mechanical electrical engineer officer, power stations, electrical installations, semi-Diesel and high-speed engines, pumps.

Public school man, 34 years of age, knowledge of Spanish and some French. Full particulars of training and experience, names of referees as to ability, &c. if required;

Address, P5277, The Engineer Office. P5277 B

THOROUGHLY Practical ENGINEER SEEKS APPOINTMENT (home); at present abroad. Wide experience with erection and maintenance of Diesel and semi-Diesel crude oil engines, suction gas plants, dredging and mining machinery, locomotives, steam cranes, engineering workshops, &c. Excellent testimonials.—Address, P5280, The Engineer Office. P5280 B

SITUATIONS WANTED (continued)

TECHNICAL ENGINEER, Bolivian, Having Practical experience in mining, civil and geological engineering, SEEKS POSITION in or out of England. Speaks English and some German; good translator and best references.—Address, P5302, The Engineer Office. P5302 B

WORKS MANAGER (44), 1st Class B.O.T. Cert., A.M.I.N.A., DESIRES RE-ENGAGEMENT, home or abroad; intimate knowledge of all departments, good disciplinarian, plenty of initiative; excellent testimonials.—Address, P5301, The Engineer Office. P5301 B

A CAPABLE DRAUGHTSMAN REQUIRES A SITUATION. Experience: 10 years full carriage, motor car and aircraft machine detail design; 4 years mech. and general engineering, specialisation work, detail and design, &c. Moderate terms.—Address, P5263, The Engineer Office. P5263 B

TECHNICAL and MECHANICAL DRAUGHTSMAN, wide experience in refrigeration, tool work and general design, SEEKS responsible POSITION.—V. N., 33, Camden-square, N.W. 1. P5303 B

YOUTH, Aged 17, Just Left Trade School, REQUIRES SIT. in Drawing-office as Tracer. Well recommended.—Address, J. H. VINCE, 180, Hanworth-road, Hounslow. P5911 B

FOREMAN BOILERMAKER, Disengaged, Non-union man, SEEKS POSITION as Foreman on Locomotive or Stationary Boilers or General Work; 15 years' experience as head foreman, home and abroad; total abstainer; good references.—Address, P5271, The Engineer Office. P5271 B

PARTNERSHIPS

ENGINEERING PARTNERSHIPS AND BUSINESSES.

Wheatley Kirk, Price & Co.
46, Watling Street, London, E.C. 4.
Established seventy years.

PARTNERSHIPS, DIRECTORSHIPS, with Active EMPLOYMENT, WANTED in well-established businesses in town and country for sons less than £500. We send you list of investors showing their qualifications, past experience, and capital available. Copies of your last balance sheet and profit and loss a/c required.—OFFICERS' PARTNERSHIP GUARDIAN, 116, Victoria-street, S.W. 1. Call. 8047 C

WILL GENTLEMAN, Well Known in Engineering industry, both commercially and financially, please APPLY to ADVERTISER regarding a well-thought-out scheme for promoting trade, saving manufacturers' money, and offering great assistance to buyers. Small capital required to start, but needs some well-known "figure-head" to back it with his name. Offers from real individuals only.—Address, 8026, The Engineer Office. 8026 C

For continuation of Small Advertisements see page iii

The Liquidators of an Antwerp Boat Building and Ship Repairing Company

OFFER FOR SALE

the following lots, together or separately, and invite Tenders:

1. A Complete **ENGINEERING INSTALLATION AND EQUIPMENT,** electrically driven, in running order, and consisting of shaping machines, precision lathes, large model rapid lathe, shearing, punching and drilling machines, shearing and punching machine (large model driven by 18 h.p. motor), sheet rolls, motors, forges and complete tool equipment, with large stock of angle bars, steel plates, etc.

   The Proprietor of the Building would arrange a Lease.

2. **A SHIPYARD AND DRY DOCK** (Freehold) capable of taking Vessels up to 1000 tons, situated at Burght, near Antwerp; ready for immediate use. The Yard is situated on the left bank of the River Scheldt. It has an area of over 7000 square metres; contains a modern equipment of tools and machinery for working wood and metal, including punching, shearing, bending and drilling machines, forges, air compressor set, large stock steel plates, angle bars, bolts, rivets, wood and various materials. Dimensions of Dry Dock, 77 × 11 metres.

   Also includes Buildings as follows:—

   (1) Manager's Dwelling House.
   (2) General Office and Drawing Office.
   (3) Store Room.
   (4) A Building over 30 metres in length, equipped on Ground Floor as Carpenters' Shop, and above as Tracing Office.
   (5) Engine Room and Dynamos.
   (6) Workshop equipped with Forges, Machines, etc.
   (7) Other Buildings for use as Dining Room, Stock Rooms, Hangars.

   The whole enclosed by brick walls, and easy of access.

Complete Inventories of both Plants, Machinery and Stocks can be obtained on request.

Tenders to be submitted by 15th May next to:

C. J. Marshall, *Chartered Accountant,* **20, Eastcheap, London, E.C. 3.**

Developments in Power Station Design.

No. XXVIII.*

THE Hick-Breguet surface condensing plant as made by Hick, Hargreaves and Co., Limited, of Bolton, is a good example of a modern high vacuum plant in which the air and water are extracted entirely independently of one another at different points in the manner already described, so that the condensate can be withdrawn at maximum temperature and the air at minimum temperature and maximum density. The air may be withdrawn from condensers in accordance with several methods, namely, (1) by multiple steam jet two-stage ejectors, with or without an intermediate condenser; (2) by a single steam jet first-stage and water jet second-stage ejector; (3) by water jet air ejectors; (4) by a rotary hurling water pump; and (5) by single steam jet two-stage ejectors with an intermediate condenser. In the Hick-Breguet surface condensing plant the last-mentioned scheme is adopted and the apparatus employed is known as the "Ejectair," whilst a centrifugal pump is used for extracting condensate. The various parts of the plant, which are shown in Fig. 145, comprise the condenser itself, the rotary circulating and extraction pumps, and the air extractor. The circulating pump calls for little comment, for it is a standard low-lift machine, but the centrifugal pump for extracting the condensate is, on account of the very high suction lift, of special design, the lift, when the pump is extracting water under a vacuum of 28in., being about 31.6ft., and to obtain satisfactory working it is necessary to give a head on the suction side of not less than 20in., so as to ensure a flow of condensate into the pump. When the delivery head against which the pump operates does not exceed 45ft., the makers fit a single-stage pump, but when the elevation of the feed tanks, &c., necessitates a greater lift, an additional pump, known as a lift pump, is installed. Provided the head on the suction side of the extraction pump is not less than that mentioned above, this unit may be placed in any convenient position adjacent to the condenser.

The "Ejectair," which is shown in Fig. 146, comprises a first and second-stage single steam jet with an intermediate condenser. Air is drawn from the condenser at A and is compressed by a steam jet at B, and the steam and air mixture is then discharged into the intermediate or auxiliary condenser C, where the air is cooled and the steam condensed by the water jet D, the air being withdrawn from the auxiliary condenser and discharged to the atmosphere or feed heater by the second-stage ejector E. As the vacuum in the auxiliary condenser is usually about 4in. less than that in the main condenser, the condensate from the latter can be used in the auxiliary condenser. If, for example, the vacuum in the main condenser is 28in. and the condensate temperature 96 deg. Fah., the water can be used for condensing steam in a mixture of steam and air under a vacuum of, say, 24in. and at a temperature of about 130 deg. Fah. The water from the auxiliary condenser is drained away by passing it back to the extraction pump suction by means of a "balance pipe," which, in addition to draining the auxiliary condenser, also provides the balance of pressure between the latter and the main condenser.

Nearly the whole of the heat of evaporation of the steam used in the jets is recoverable. That from the first jet is added to the condensate withdrawn from the main condenser by passing it through the drain balance pipe from the auxiliary condenser, whilst the heat from the second jet is usually absorbed in a feed heater, the condensate from the main condenser providing the condensing medium. The "Ejectair" is fitted with a stabilising air valve G, which ensures stability of vacuum under all conditions of load. Some of the condensing plants of this type that are in the course of construction have a capacity of 20,000 kilowatts.

The plant shown in Fig. 154 on page 463 comprises a 12,000-kilowatt, 3000 revolutions per minute Metropolitan-Vickers turbo-alternator set built for the Bolton Corporation. The Hick-Hargreaves condenser is designed to condense 160,000 lb. of steam per hour and to maintain a vacuum of 28in. when supplied with cooling water at a temperature of 75 deg. Fah. The cooling surface is 23,500 square feet and the amount of cooling water required is 1,119,960 gallons per hour. The condenser contains 7100 brass tubes which have an external diameter of ⅞in. and are arranged for two passes. The internal diameter of the shell is 9ft. 3in., whilst the length between the tube plates is 16ft. 10½in. Each tube plate, which is in a single piece, is 10ft. ¼in. in diameter and 1¼in. thick. The 30in. electrically driven circulating pumps, which run at 325 revolutions per minute, are designed to deliver against a head of 28ft. Care has been taken in the design of the condenser to ensure that the steam makes intimate contact with the whole of the tube surface so as to secure maximum efficiency. The tubes are, moreover, disposed so that the resistance to the passage of steam through the condenser is reduced to a minimum.

To ensure that the air is withdrawn from the condenser at maximum density a devaporising chamber is provided in the lower pass, the chamber being formed by means of steel plates running from one end of the condenser to the other. At each end of this chamber openings are provided through which the air is drawn. The air passes among the tubes in the devaporising chamber, and, owing to the reduction in volume, the air extraction apparatus is able to work with maximum efficiency. The Hick-Breguet "Ejectair" to which we have alluded is designed for dealing with about 160 lb. of dry air per hour and is

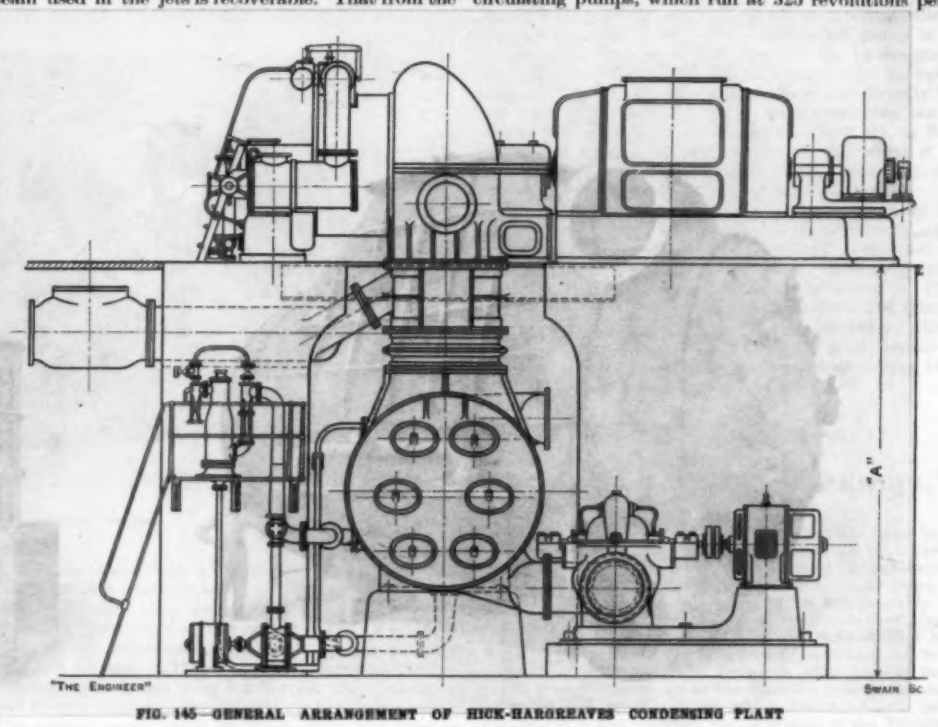


FIG. 145—GENERAL ARRANGEMENT OF HICK-HARGREAVES CONDENSING PLANT

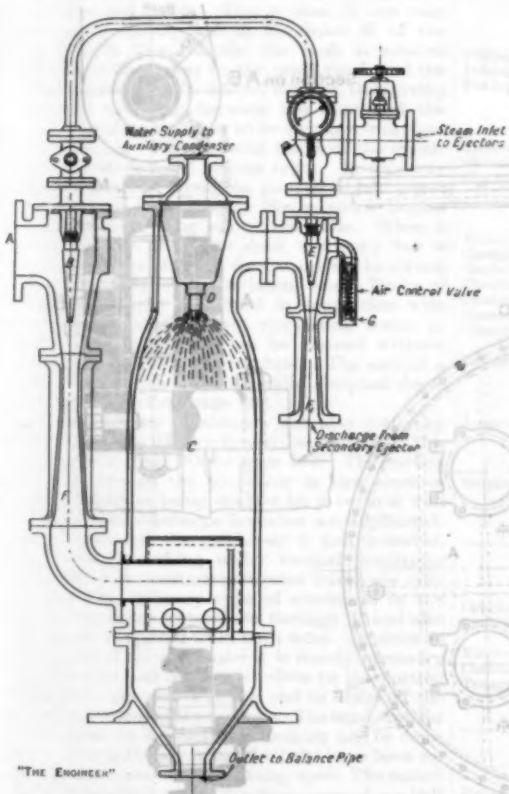


FIG. 146—THE "EJECTAIR"

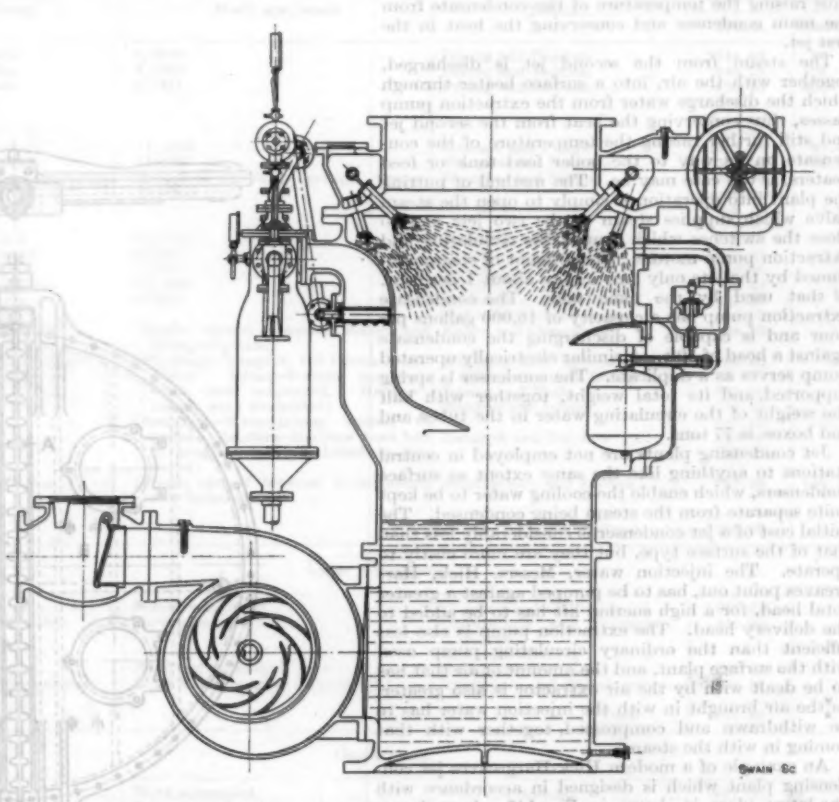


FIG. 147—ARRANGEMENT OF HICK-HARGREAVES JET CONDENSER

* No. XXVII. appeared April 14th.

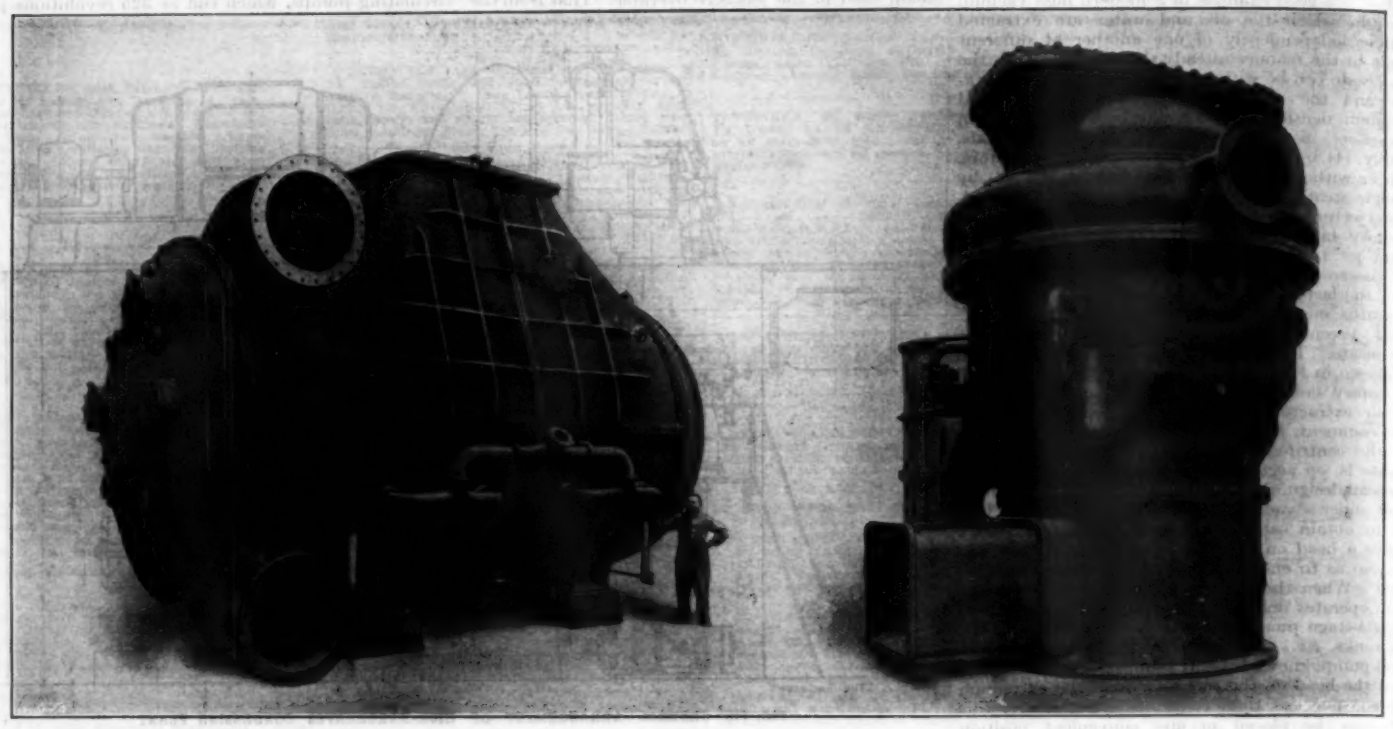
operated by two steam jets in series with an intermediate condenser, which makes it possible to obtain a high degree of air extraction combined with a low steam consumption. The first jet withdraws the air and other incondensible gases from the condenser, compresses it slightly and discharges it into the intermediate condenser, where the steam from the first jet is condensed and the air and other incondensible gases are reduced in volume, so that the volumetric efficiency of the second jet is increased. The water from the auxiliary condenser, together with the condensate from the first jet, is delivered by means of the U balance pipe direct into the extraction pump suction, thus raising the temperature of the condensate from the main condenser and conserving the heat in the first jet.

The steam from the second jet is discharged, together with the air, into a surface heater through which the discharge water from the extraction pump passes, thus conserving the heat from the second jet and still further raising the temperature of the condensate on its way to the boiler feed tank or feed heaters, as the case may be. The method of putting the plant into operation is simply to open the steam valve which supplies steam to the two jets and to close the switches which control the circulating and extraction pump motors. The amount of steam consumed by the jets only amounts to about 1 per cent. of that used by the main unit. The condensate extraction pump has a capacity of 16,000 gallons per hour and is capable of discharging the condensate against a head of 50ft. A similar electrically operated pump serves as a duplicate. The condenser is spring supported, and its total weight, together with half the weight of the circulating water in the tubes and end boxes, is 77 tons.

Jet condensing plants are not employed in central stations to anything like the same extent as surface condensers, which enable the cooling water to be kept quite separate from the steam being condensed. The initial cost of a jet condenser is considerably less than that of the surface type, but they are more costly to operate. The injection water, Messrs. Hick, Hargreaves point out, has to be pumped against a greater total head, for a high suction lift has to be added to the delivery head. The extraction pump is also less efficient than the ordinary circulating pump used with the surface plant, and the amount of air that has to be dealt with by the air extractor is also greater, as the air brought in with the injection water has to be withdrawn and compressed, together with that coming in with the steam.

An example of a modern Hick-Hargreaves jet condensing plant which is designed in accordance with the latest ideas is shown in Fig. 147. In it the air and water are withdrawn at different points, and it is arranged so that the air is withdrawn at maximum density. The steam, which is free to pass into the condenser through an unrestricted passage, meets with the injection water in the form of a fine spray, and as every particle of water does its proper share of work the maximum condensing effect is produced. The nozzles which provide the sprays are very simple and only require a head of 3ft. to 5ft. of water.

The condensed steam and injection water fall to the bottom of the condenser, where they are withdrawn by the centrifugal extraction pump, whilst the air and other incondensible gases are extracted by an "Ejectair" as used in conjunction with the makers' surface condensing plant. For the purpose of preventing the water flooding the turbine, a vacuum breaker is provided. The water from the auxiliary condenser in this type of plant is returned to the main condenser through a pipe, whence it is discharged, together with the other water. Because of the extra amount of air that has to be handled, the steam consumption is greater than that of the jets belonging to a surface condensing plant. The power required for operating the extraction pump naturally varies with the delivery head, and is usually greatest when the pump has to discharge the water over cooling towers. The temperature of the hotwell is usually maintained within 5 degrees of that corresponding to the vacuum and the amount of injection water is thus reduced to the required minimum. To ensure that the air and water extractors are fully capable of meeting their specified duties, they are tested at the makers' works under conditions which as far as possible correspond with those under which the plant actually has to work. Views of the jet and surface condensers are given in Figs. 148 and 149. A jet condensing plant has recently been installed by Hick, Hargreaves and Co., Limited, in the Cronton Colliery power station of the Hulton Colliery Company. This condenser, which works in conjunction with a Richardsons, Westgarth 2000-kilowatt turbo-alternator, has been designed to deal with 33,000 lb. of exhaust steam per hour, and to maintain a vacuum of 27½ in. when supplied with cooling water at a temperature



FIGS. 148 AND 149—HICK-HARGREAVES SURFACE AND JET CONDENSERS

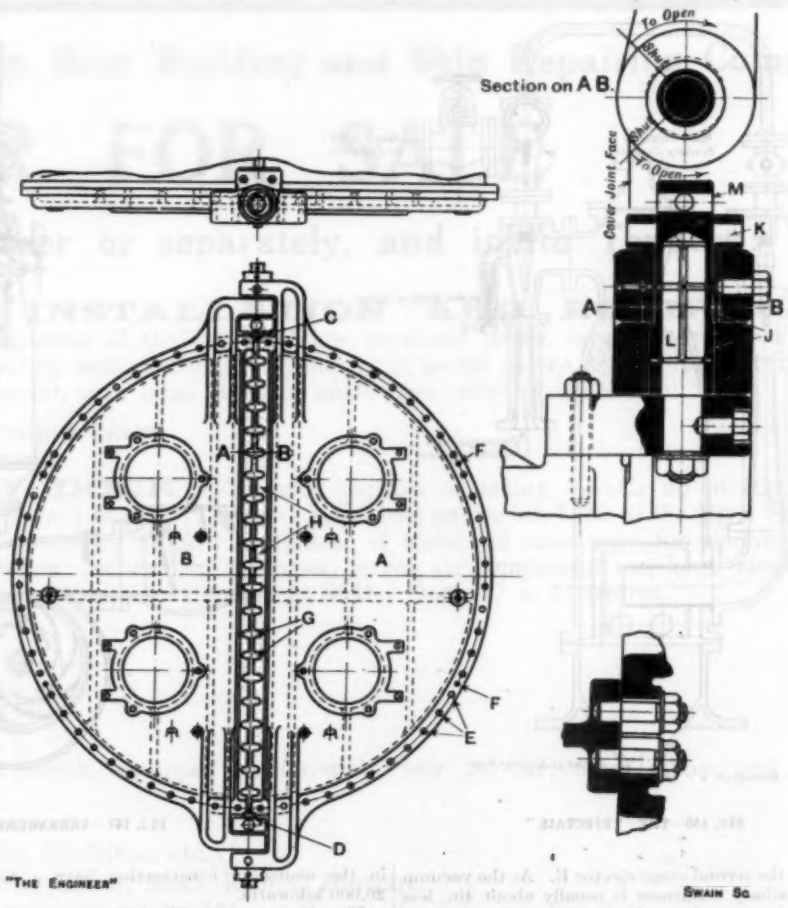


FIG. 150—ARRANGEMENT OF DOORS FOR A CONTINUOUS SERVICE CONDENSER

not exceeding 80 deg. Fah. An interesting feature of the plant is that the electrically driven extraction pump spindle is extended, and is fitted with a belt pulley mounted on a Whittaker Hall clutch, so that the pump may be driven by a small steam engine in the event of the electric current failing.

A special arrangement has been devised by Hick, Hargreaves and Co., Limited, for facilitating the opening of condenser doors when they are formed in two parts and carried on a central hinged pin. The principal characteristics of the scheme are the provision of means whereby the joint between one half of the door and the condenser can be broken independently of the other joint between the other half of the door and the end of the condenser. In Fig. 150 the two parts of the complete door are shown at A and B and each part is carried on a hinge C and D. To open either part of the door the joint bolts E and the nuts on the studs at G are removed and forcing screws F are then employed in the ordinary way for breaking the joints. Difficulty is, however, liable to be met with in opening the doors A or B on account of them being close to the central bar on the end of the condenser, any jointing material at the point H being scraped off, whilst the door is being swung open and again when it is closed.

To overcome this difficulty, however, each of the hinged doors is provided with an excentric bush J, which enables each door to be forced away from the facing on the end boxes. This is done in one case by inserting a tommy bar in the holes K of the bush J, and in this manner the bush is rotated excentrically with respect to the main pin L and the door is moved away in the desired manner, thus giving the requisite clearance between the door and the facing and enabling the door to be swung round clear of the box facing. When closing the door the operations are repeated in the reverse order. In this way the jointing material along the joint H is left intact and the pressure is applied by the excentric bushes prior to the nuts G being put on the studs. When it is desired to open the other door, a tommy bar is placed in the holes M. The door can then be swung open independently of the adjacent one. Doors of this type are usually employed in connection with surface condensers using dirty circulating water, as one half of the condenser can be cleaned without entirely shutting down the machine. The end of a condenser fitted with these specially designed doors is shown in Fig. 152 on page 463.

Continuous service condensers are also made by other firms, and a Brown-Boveri condenser of this type is shown in Fig. 153 on page 463. The cooling water flows through the condenser in two streams, the water chambers being divided by a vertical wall and the inlet and discharge branches are duplicated. The steam space of the condenser is not, however, divided. When working under normal conditions the Brown-Boveri continuous service condenser only differs from the ordinary type of condenser in the manner in which the water flows through it, and also in that the air is ejected from both sides. In order to clean one half of the condenser it is merely necessary to close the inlet and discharge valves on the portion it is desired to put out of action and to drain off the water which remains in that section. The semi-circular cover can then be opened and cleaning can be commenced. It is said that when the bolts have been removed the doors can easily be swung open. The reduction in vacuum which occurs in consequence of one half of the condenser being put out of commission is stated to be only about 3 per cent. at full load, whilst at half load it is somewhat higher than that obtained with both the sections in use under full load conditions. As when working with only one half of the condenser in use the vacuum only decreases from, say, 95 per cent. to 92 per cent., the temperature of the exhaust steam only increases from 34 deg. Cent. to about 42 deg. Cent., the increase in temperature is insufficient to have a detrimental effect upon the tubes or the packing. The makers also point out that as no condensation takes place in the part of the condenser that is out of action, and as in the portion in which the cooling water is circulating the volume of the steam is reduced by a very large amount, the steam naturally flows to the working side. The two-part condenser enables cleaning to be carried out as often as may be desired without putting the turbine out of service.

A typical arrangement of the pumps for a Brown-Boveri surface condenser is shown in Fig. 151, where

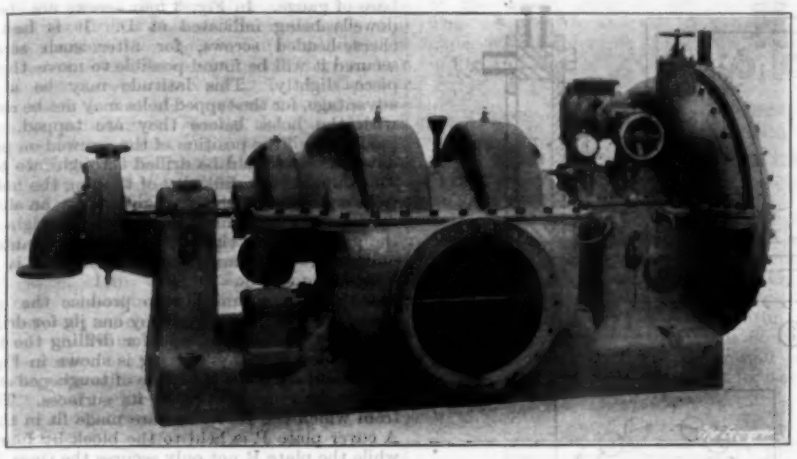


FIG. 151—BROWN-BOVERI CONDENSER PUMPS

it will be seen that all the necessary pumps are mounted on a common shaft. Only two bearings are employed, and they are cast in the bed-plate and support the rotors of all the pumps. The air is drawn off from the condenser by a water ejector which is supplied by one of these pumps. Between the two bearings, which are ring lubricated, the circulating and ejector pumps are arranged in a common housing. The ejector pump takes its water from the pressure volute of the circulating pump and raises it to the necessary pressure for the operation of the ejector, an arrangement which offers the advantage that only one suction gland and one pressure gland are required for the two pumps.

The condensate pump is bolted on the outboard bearing, and its impeller is overhung on the extension of the main shaft. No packing gland is therefore required on the suction side of this pump. The circulating pump is fitted with a bronze impeller, the bronze diffuser being arranged in the cast iron pressure volute. The ejector pump may be a standard centrifugal machine, with one or two stages working with a normal water velocity. The pressure of the water delivered by the pump is converted into velocity in the ejector only, so that excessive wear of the pump due to high velocity is avoided. As the water branches of the circulating and ejector pumps are cast on the lower half of the housing the upper half can easily be lifted for inspecting the interior of the pumps without dismantling any of the pipe work. The condensate pump is a single-stage centrifugal machine. It can be designed for a head of about 20ft. under normal working conditions, and it is able to deliver the water directly to the hotwell without the use of an intermediate tank. Pumps of this type must be placed about 2ft. or 3ft. below the bottom of the condenser, but when it is impossible to place the whole of the pumping set at this level a special vertical pump is supplied.

The Brown-Boveri condenser pumping sets may be driven by a steam turbine or by an electric motor, and in some instances a motor is connected to one end of the shaft and a turbine to the other. Normally, the motor can drive the set, but in the event of the supply failing or the motor breaking down the steam turbine governor, which is set to open the valves when the speed of the set drops below a predetermined value, comes into action and the turbine drives the set instead of the motor.

Chinese Government Railways.

SOME idea of the extent to which railways have been developed in China may be gathered from the table given below, which is based on information issued by the Government Bureau of Economic Information, while there is also an indication of the schemes which will probably be put in hand in the future. The table deals with the Chinese Government Railways, and it will be noticed that the Kiachow–Tsinan line is not included, as it had not been restored to China by the Japanese after having been taken from the Germans at the time the information was compiled. A small project which has only just been announced is also omitted, viz., a branch of the Taokow–Chinghua line, from Wanmeng across the Yellow River to Loyang, which will connect it with the Lung-Hai Railway. Considering the area of China, and comparing it with other countries, the existing five thousand odd miles of Government railways are a most inadequate means of communication, and even when the proposed other five thousand miles have been completed it is obvious that there will be ample room for more construction. The latest returns show that the total revenue of the railways amounts to some 8,300,000 dols. per month, of which over one-half is contributed by the three main arteries —Peking–Hankow, Peking–Mukden and Tientsin–Pukow.

Table of Chinese Government Railways.

Completed.

Railway.	Work completed.	Termini.	Length in kilometres. Trunk.	Branches
Peking–Hankow	5/1905	Peking and Hankow	1214.49	98
Peking–Mukden	2/1905	Peking and Mukden	846.73	128
Peking–Suiyuan	5/1921	Peking and Suiyuan	428.75	665
			145 (Suiyuan–Paotowchen)	
Tientsin–Pukow	11/1912	Tientsin and Pukow	1008.96	97.86
Shanghai–Nanking	11/1907	Shanghai and Nanking	311.00	16.09
Shanghai–Hangchow–Ningpo	Hangchow–Shaohing section uncompleted	Shanghai and Ningpo	259.00 (completed)	
			69 (H–S section)	5.66
Kirin–Changchun	10/1912	Towtaokow and Kirin	125.40	
Chengtch–Taiyuan	8/1907	Shihchiachwang and Taiyuan	242.95	2.45
Taokow–Chinghua	1/1907	Chinghua and Sanliwan	150.00	
Chuchow–Pinghsiang	10/1905	Anyuan and Sinho	90.50	
Canton–Kowloon	8/1911	Tashatow and Kowloon	143.29	
Canton–Samshui		Shihweitan and Samshui	48.92	
Changchow–Amoy	(Traffic opened between Kaoyu and Kiangtungchiao)	Kaoyu and Changchow	28.00	
Hankow–Canton–Chengtu	(Wuchang–Changsha, 450 kiloms., completed. Ichang–Kweifu surveyed, work now suspended. Hankow–Ichang work suspended)	Wuchang and Chuchow, about 20 miles south of Changsha	750.00	
		Ichang and Weifu	200.00	
		Hankow and Ichang	285.00	
Lung-Hai	(Hsuchow – Kwanyintang opened to traffic. Hsuchow–Haichow road bed in progress. Honan–Lanchow surveyed)		480.00	
		Lanchow and Haichow	580.00	
			733.00	
Soupingchieh–Taonan	(Traffic opened between Soupingchieh and Tsenchiatun)	Soupingchieh and Taonan	227.00	113.7
		Total	8386.99	

Under Construction.

Chuchow–Chinhsien	Survey completed	Chuchow and Chinhsien	965.00	
Chowchiakow–Fenchen	Survey completed	Chowchikow and Fenchen (Hupeh)	362.00	
Kirin–Huining		Kirin and Huining		
Chefoo–Weihsien	Road bed completed	Chefoo and Weihsien	288.98	
Tsangchow–Shihchiahwang	Road bed in progress of building	Tsangchow and Shihchiachwang	222.00	
		Total	1837.98	

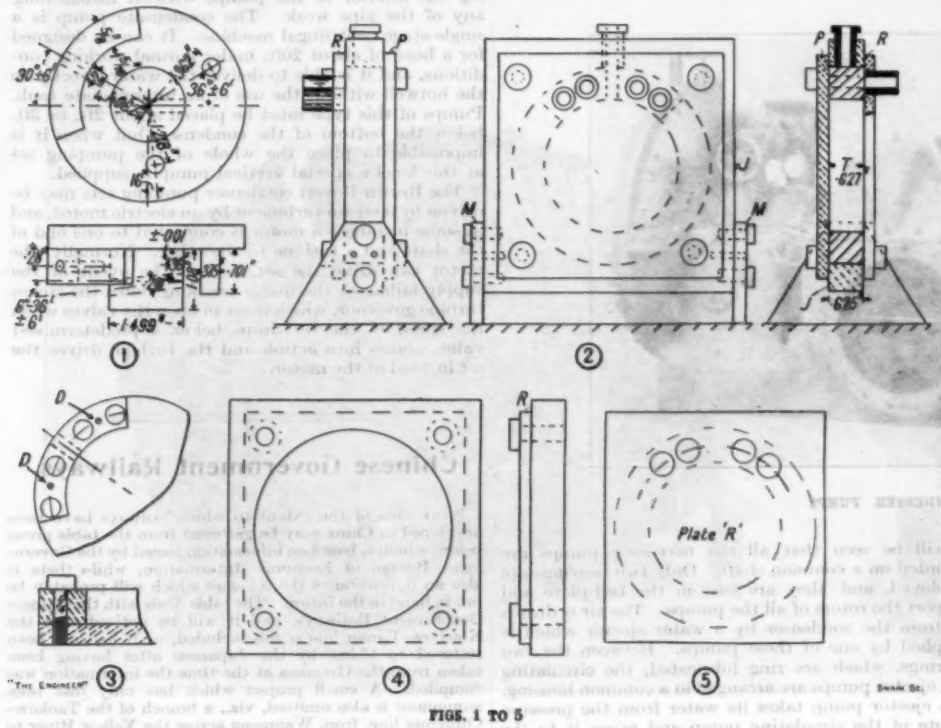
Contemplated.

Pukow–Sinyang	Work suspended	Wuyi and Sinyang	437.00	
Nanking–Siangtan	Survey completed	Nanking and Siangtan	992.00	
Harbin–Heilungkiang		Harbin and Heilungkiang	1060.00	
Chinhsien–Chungking		Chinhsien and Chungking	1130.00	
Tatung–Chengtu	Survey completed	Tatung and Chengtu	1600.00	
Shasi–Singyi		Shasi and Singyi	1236.00	
		Total	6455.00	

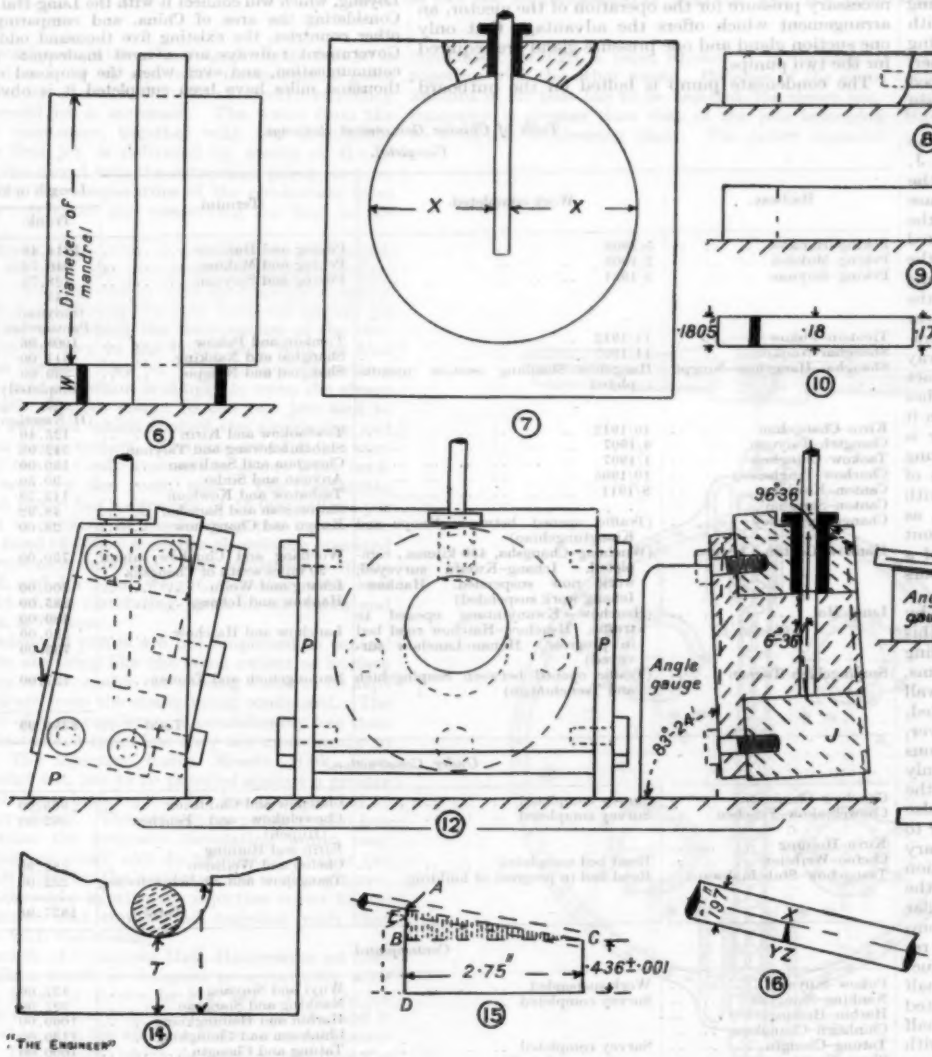
Position Gauges and their Jigs.

By ARTHUR G. ROBSON, A.M.I. Mech. E.

Position gauges usually require a considerable amount of skilful manipulation in order finally to determine the relative positions of details. There is a twofold aspect of this work, viz., the sizes of the parts of the gauge and the positions of those parts. It is, therefore, not surprising to find position gauges classified with work demanding the most careful and skilful workmanship. As there are "tolerances" allowed on most of the dimensions, the worker is given a little latitude within which the sizes and positions of the details must be confined. It is very advisable to take advantage of such tolerances. Where pins, for instance, should be "low," the low sizes should be worked to within .0002in.; or, if the holes should be "high," they should be approached to within .0002in. Even with very careful working, and allowing for slight inaccuracies that may be anticipated, this work may be found a trifle tedious, and usually a certain quality of mind is also necessary successfully to accomplish a large amount of work of such an exacting nature.



FIGS. 1 TO 5



FIGS. 6 TO 16

In Fig. 1, details of a position gauge are shown. They include a boss 1.499in. diameter with a .201in. hole inclined at 6° 36'. The position of the inclined hole is on the centre line of the boss within .0003in., and the lower exit is .436 ± .001in. from the face of the base of the gauge. The quadrant portion of the gauge has a .2in. pin secured at 30° to the centre line of the inclined hole and boss, and the end of the pin is 1.062in. from the centre of the gauge. Finally, two pins of the diameter and length shown are secured at 36° 6′ and 16° respectively, in the positions shown in the elevation.

It is proposed to have the quadrant piece, although actually not quite a quadrant, independent of the body of the gauge, and to dowell and screw it to the base of gauge. In Fig. 3 four screws are shown, the dowells being indicated at D. It is best to use cheese-headed screws, for after such screws are secured it will be found possible to move the curved piece slightly. This latitude may be a distinct advantage, for the tapped holes may not be concentric with the holes before they are tapped. Having finally found the position of the screwed on piece, the dowell holes should be drilled through into the base. To overcome the difficulty of tapping the holes so as to be concentric with the original holes, an alternative arrangement is to make the screws pass right through the gauge, fitting tightly, and to secure nuts on the underside. This arrangement, however, is perhaps a little clumsy.

In order economically to produce the quadrant piece, it is proposed to employ one jig for drilling the hole for the .2in. pin, and for drilling the holes for the holding screws. This jig is shown in Fig. 2. It consists of a jig block J made of toughened steel, and accurately ground over all its surfaces. The rings from which the part rings are made fit in the block. A cover plate P is held to the block by four screws, while the plate R not only secures the rings, but acts also as a jig for drilling the four holding-down holes. The block is ground, as shown, .625in. thick, but the rings are made .002in. thicker so as to admit of their being secured firmly in the block. In order to provide a large base for supporting the block, two plates M are bolted and dowelled to its side. To permit the correct marking off of the plate R for the thimbles, this plate should be held to the block, as in Fig. 4, and in this position a circle should be marked by a scriber on the inside of the plate of diameter equal to that of the hole in the block. The plate can then be removed, and the centre of the scribed hole found. From this centre the pitch circle of the four thimbles is marked and the holes are drilled as in Fig. 5. As the holes for the screws—Fig. 3—are ¼in., the holes for the thimbles will be about ¼in. diameter. For drilling, the jig block is merely rested upon a true drill block with the plate P downwards. As the holes must be given an allowance for reamering, they

should be drilled about .004in. less than .25in.

We have next to concern ourselves with the hole for the .2in. pin. As this pin is radially situated, the thimble must be central with the jig block hole. In Fig. 6 the block is shown with a tightly fitted mandrel in the central hole. By adding the width W to the radius of the mandrel, the height of the centre from the base is obtained. A centre line can then be marked horizontally by means of a scribing block, a steel rule divided into hundredths of an inch, and a magnifying glass. By careful working it will be found that the drilled hole will be reasonably near to its true position. The hole in the thimble will be central when a mandrel placed through it gives, by a pin gauge, equal distances X—Fig. 7. At the same time the mandrel must also be parallel with the base of the gauge, as in Fig. 8. Finally, the plates M must be so secured that a mandrel in the bush in Fig. 2 shall be square with the base upon which the plates M are supported. If the drilled holes are less than .2in., the allowance for reamering can be utilised for securing the true position of the .2in. pin. The height of the axis of the pin from the base of the gauge is .28in.—Fig. 1. To secure this dimension a small gauge, .18in. wide, is applied, as shown in Fig. 9, under the .2in. pin. If the small gauge is slightly tapered, as in Fig. 10, that is, so as to have a difference of .001in. in its length and the nominal size at the centre, the operation is made easier.

It is not proposed to secure the .2in. pin in position at the present stage. This will be the last item to adjust and correctly determine. The boss and base of the gauge may be made from one piece of solid steel, or the boss may be independent and held to the base. It does not really matter much where the boss is secured, except, of course, that it should be reasonably near the centre of the base. The centre of the boss, however, becomes the centre from which all our measurements and positions are determined. Passing through the boss is a .201in. hole inclined at 6° 36′ ± 6′. The angle must therefore be between 6° 30′ (the low limit) and 6° 42′ (the high limit). As shown in Fig. 11, the height of the centre of the exit must be .436 ± .001in. We have now to design a jig for locating the .201in. hole correctly to within .0003in. of the centre of the 1.499in. boss, and for fixing the height of its exit at .436in. ± .001in.; its angle and its diameter. The jig is shown in Fig. 12. The jig block J, which has the gauge held to it, is supported by the two side plates P. As shown in the sectional elevation, the drilled hole will be correctly situated for angle if an angle gauge of 83° 24′ fits as represented. The jig block J must be ground to suit the boss of the gauge, and the faces must be square and parallel with the bored hole of 1.499in. diameter. The first step will be to cut away one side, as shown, to an angle of 96° 36′, so as to give a normal surface for drilling the bush hole. We require to know where the bush hole shall be drilled so as to bring the axis of the hole on the other side of the boss at a height of .436 ± .001in., as in Fig. 13. Evidently the height gauge G must just touch the pin, and the angle gauge of 6° 36′ must lie along the surface of the pin. The thickness T of the block is found as in Fig. 14. The overall measurement from a lapped pin to the outer face is found by means of a micrometer, and by deducting the pin diameter the thickness T is found. We may assume it to be 1.251in. To this figure must be added the diameter of the boss 1.499. The base of the triangle in Fig. 15 is therefore 1.499 + 1.251 = 2.75in. The height A B = 2.75 tan 6° 36′ = 2.75 × .1157 = .31875in. The height of the height gauge = .436 + .31875 = .75475in. This would be to the axis of the pin. The height gauge will therefore be .75475 less the distance X Z, in Fig. 16. Now

$$XZ = \frac{XY}{\text{Cos } 6° 36'} = \frac{.197}{2} = \frac{.0985}{.9934} = .09915\text{in.}$$

Therefore E D, Fig. 15, = .75475 − .09915 = .6556in. Turning back to Fig. 13, the pin passing through the thimble is made central by a pin gauge applied to each side, as shown in the plan. In the case of holes requiring adjustment after the bushes are fitted, the bushes may be made slightly excentric.

The jig block is now fixed, as in Fig. 12, by the angle gauge, and a square applied to test the mandrel. The final hole, .201in., is drilled .004in. smaller, and then enlarged by successive steps of .001in. Upon each enlargement a hardened ground pin is placed in the hole, and tests are made for the angle, centrality and height of exit. The arrangement for trying the error of the centre line is shown in Fig. 17. The gauge is held against the back face and the upper faces of a rectangular channel block. By means of a universal test indicator the heights of the top and bottom surfaces of the boss can be determined. If there is a difference in the readings of, say, .004in., the hole is .002in. off the centre line. We therefore note the direction in which the hole must be reamered, and at the same time test the height of the exit. This height is determined by using ground rollers passing under the pin, as shown in Fig. 18. The sizes of the rollers are calculated for the "high" and "low" limits of H in the figure, viz., .437in. and .435in. respectively. As an example we will work out the size of the roller for the nominal size of the angle, viz., 6° 36′. In Fig. 19, angle C A B = 6° 36′, and

$$AC = \frac{AB}{\text{Cos } 6° 36'} = \frac{.1005}{.9934} = .1012\text{in.}$$

∴ Height P = H − A C = .437 (high limit) − .1012 = .3358in.; also P = S + R, and angle R T S = $\frac{90° - (6° 36')}{2} = 41° 42'$.

In the triangle R T S, S T = R S cot 41° 42′ or S = R (rad. of roller) × 1.1223.

∴ P = 1.1223 R + R or R = .3358/2.1223 = .1582. The diameter of the roller is therefore .3164in.

We must work now so that in bringing the hole or the centre line the "low" pin must pass under freely whilst the upper limit pin refuses to go under. There is nearly two thousandths of an inch difference between the sizes of the rollers, so that a reasonable tolerance is allowed on the work.

We have now to deal with the jig for the position of the two .375in. pins in Fig. 1. The jig consists of three parts, as shown in Fig. 20, namely, the plate T with the bushes, and fitting over the boss of the gauge, the plate R with a circular hole for the flange of the gauge, and a back plate P. To locate the positions of the bushes we find the distances K and D in Fig. 20. These measurements are taken to the under surfaces of the pins in the bush holes, measuring from the two faces at right angles to each other. In Fig. 21, the radial distances and angles are shown, and the heights of the axis from each face (A B, B C) are shown, and are obtained by the method of Fig. 6.

(1) Considering the top hole,

E F = D F sin 36° = 1.362 × .5878 = .8006in.

and

D E = D F cos 36° = 1.362 × .8090 = 1.1086in.

∴ K = 2.186 + E F = 2.186 + .8006 = 2.9186in.

and

D = 2.164 − D E = 2.164 − 1.1086 = 1.0554in.

(2) For the lower hole,

D G = 1.218 × cos 16° = 1.218 × .9613 = 1.1709in.

and

G H = 1.218 × sin 16° = 1.218 × .2756 = .3357in.

∴ K = 2.186 − 1.1709 = 1.0151in.

and D = 2.164 − .3357 = 1.8283in.

These distances are to the centres of the bush holes; as the drilled holes will be .37in. diameter, we must deduct the radius, .185in., from the measurements. It should be noted that the distances D and K must only be tried when the .21in. inclined pin is set horizontally. The radial distances are best checked by measuring from the boss to the outside of the pins. For example, the final measurement, 2.299 in Fig. 22, is the radius of the boss + the radial distance + the radius of the pin. The other pin should measure 2.155in., as shown. As a final check for these pins we may find the length b in Fig. 23. Now $b^2 = a^2 + c^2 - 2ac \cos B$.

∴ $b^2 = (1.218)^2 + (1.362)^2 - (2 \times 1.218 \times 1.362 \cos 110°)$.

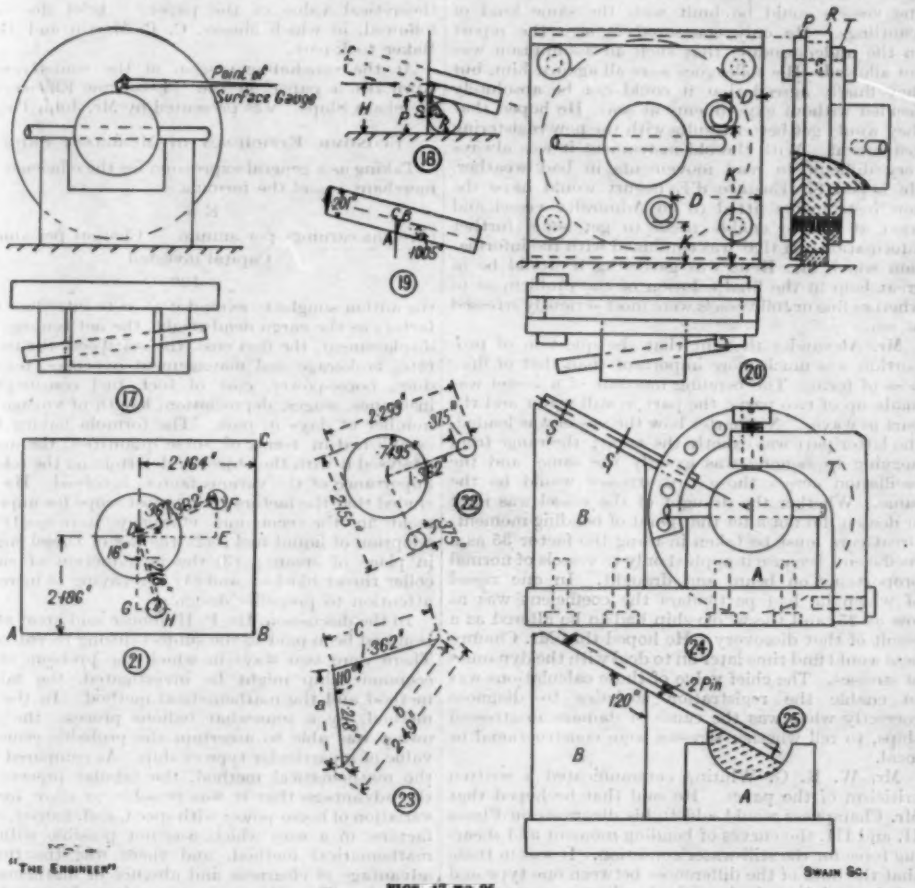
∴ $b^2 = 4.4732$.

∴ $b = 2.115$in.

The overall measurement of the final pins is 2.115 + .375 = 2.49in., as shown.

The final step is to drill the holes in the flange of the gauge to secure the quadrant-shaped pieces. The angle of the pin—as shown in Fig. 1—must be 30° ± 6′, and it is very important that the centre line of this pin should intersect the centre of the boss. The jig for this part of the work is rather elaborate. It is shown in Fig. 24. The gauge rests upon the piece A secured to the base. An angle piece B of 120° is made, as shown in Fig. 25, so that when a .2in. pin—see Fig. 1—is placed as in Fig. 25, its axis is radial when it rests upon the segment shaded. This segment is $\frac{1.499}{2} - .1 = .6495$in. thick. By this means the piece B can be adjusted so that the pin, when twisted by being held to the segment, just touches along the upper face. In Fig. 24, a .2 pin is shown fitting tightly in the quadrant piece, and held down by the screws S. The radial distance of the quadrant is determined by using a portion of a ring and placing it around the boss to keep the quadrant out to its position. The whole jig can then be turned over, and by means of the strap T the arrangement is rigidly secured by the top set screw. The holes are then continued through the base. This jig can conveniently be used for checking the final position of the quadrant.

The end of the .2 pin must stand 1.062in. from the centre, as in Fig. 1. This result can be secured by means of a ring, truly concentric, of (1.062 × 2) = 2.124in. outer diameter, placed over the boss. Alternatively a larger ring could have a face ground to the correct height. If the last operation is the setting of the quadrant, then we must see that there is sufficient clearance in the jig, shown in Fig. 24, to permit the two pins of the gauge to pass through. A clearance hole would therefore have to be made in the portion A, and a part of the strap T filed away.



FIGS. 17 TO 25

ACCORDING to Sir Robert Hadfield, the world's output of iron and steel during the period 1860–1920 was something like 1860 million tons, of which 660 millions may be considered lost by rusting in use. For the year 1920 the loss by rusting during use is estimated at 29 million tons, and after making allowances for protection, &c., the annual cost of wastage is probably over 700 million pounds sterling. Various investigators in England, America, and Germany have stated that the presence of copper exercises a very favourable influence upon the resistance of steels to corrosion; but Sir Robert Hadfield thinks that this beneficent effect of copper to steel has not yet been fully established, and does not generally advise its addition.

Institution of Naval Architects.

No. IV.*

The first paper taken on the morning of Friday, the 7th inst.—the last day of the meeting—was that by Mr. E. L. Champness, on "Longitudinal Strength of Cargo Vessels and its Variation with Fullness of Form," of which the following is a *précis* :—

This paper recorded the results of a theoretical investigation into the variation of statical bending moment with difference in fulness of form in a series of five cargo vessels all of length 400ft., of beam 53ft., and of depth 30ft. 9in. to upper deck at side. The block coefficients of the five vessels were 0.632, 0.67, 0.70, 0.75, and 0.80. The vessels were of the pure cargo-carrying type, with two decks and with the poop, bridge and forecastle covering 50 per cent. of the length. A fixed length of voyage was taken for all the vessels, and each, when in the loaded condition, was considered as being laden to the maximum legal draught. The strength calculations were carried out on the usual assumptions regarding length and height of waves, the shearing and bending moment curves being obtained by means of the integraph from load curves derived from weight and buoyancy curves. In investigating the hogging effect it was assumed that all the holds and 'tween decks were full of homogeneous cargo, that all the coal was burnt out, that there was no water ballast, and that all the fresh water and consumable stores had been used up, a condition corresponding to a possible arrival condition. In investigating the sagging strength, it was assumed that the vessel was without cargo but had her bunkers and water ballast tanks full and all her fresh water and consumable stores on board. The results of the calculations showed that the hogging bending moment and stresses in the full vessel of 0.80 coefficient were 37.6 per cent. greater than in the fine vessel of 0.63 coefficient, and that the increase of bending moment throughout the series was approximately proportional to the increase of displacement. On the other hand, the sagging bending moment and stresses decreased as the block coefficient increased, being greater than the corresponding hogging moment and stresses for the fine vessel and less for the full-form vessel. The paper concluded with a consideration of the effect of speed and the time element, that is to say, the time necessary for the development of the maximum stresses indicated in the calculations when the ship was driven at full power against a head sea having waves of the standard length and height.

Sir John Biles said that the continued application of scientific investigation was gradually being employed to add to their knowledge of a subject which was so very important to naval architects to-day. Mr. Champness had followed the suggestion of the Load Line Committee, that stress and strain investigations were better carried out on actual ships. Those standard calculations were more certain now than they were before the Admiralty arranged for those experiments to be carried out on H.M.S. Wolf. In that ship they demonstrated that the systematised method of calculations was reliable and could be taken as the only method of determining the best scantlings to be put in a ship. In that special case they took a destroyer and loaded her up as if she was going to sea. They put her into a dry dock on supports. They lowered the water 6in. at a time and got a very large range of useful data on the strain and stress and bending moment of the vessel. They obtained the point of elasticity and very interesting conclusions concerning the sagging and hogging strains. Then they sent the ship to sea with the same strain indicators in her. The commander was told to chase bad weather. But they got nothing like the same amount of stress at sea. In fact, the point of stress in the dock gave a maximum of about 8 tons, and at sea the maximum was about 5 tons. The vessel was driven right into the waves at 17 knots, so that a real attempt was made to break her, if she could have been broken. It was on those results that he based his faith in the safety of the guide which the standardised investigations gave them. He had recently taken part himself in some very interesting investigations in the driving of a heavy head ship into the sea on the Atlantic. From that it seemed that one could not drive ships of a certain fullness up to the speed for which power they were equipped, because of the pounding which they met with in that sea. The limit was not what the deck would stand, but what the bottom would stand. The finer ships did not pound as much as the fuller ones. It was clear that the influence of pounding required consideration from those who wanted to get the best results from ships in daily service.

Mr. Thompson said that the deductions made in the paper indicated a wide difference between the stress regulations laid down in Lloyd's rules and the recommendations of the Load Line Committee. The discrepancies between the present-day practice and that recommended by the Committee very nearly vanished, however, if other methods of drawing up examples were taken. A reasonable margin had to be provided for cases of injudicious loading. He had found that unwise loading was much more common on oil ships than in cargo ships. In some oil tankers the bending moment had been as much as 30 per cent., and it had even increased to as much as 70 per cent. The common practice of working on an average loading only seemed to meet their everyday needs. They had to remember that vessels at sea did not meet a regular series of waves, and results in actual work would be likely to be quite different from those in the calculations worked out.

Sir Archibald Denny said that Mr. Champness had referred to a paper which he (Sir Archibald) had read in 1892, which was produced as a reply to Mr. T. C. Reed's paper of 1890. In that paper he set out to disprove the deduction that a fine vessel could be built on smaller scantlings than a full one. His (Sir Archibald Denny's) paper showed that the sagging stresses as then calculated were small in comparison to the hogging stresses—about 3 tons to 8 tons. In those days they worked by a standard based on the fact that hogging was assumed when the bunkers were empty and sagging when the bunkers were full. In Mr. Champness' paper he found a still worse case for sagging, and that was with light bunkers. He came to the same conclusion as the speaker, that fine vessels could be built with lighter scantlings. What Sir John Biles had said about pounding being more evident in full vessels than in fine ones was, he believed, true. The suggestions of Mr. Champness as to the necessity for experiments on actual sea-going vessels as laid down by the Load Line Committee was particularly interesting to the speaker, because when that report was drawn up he found it impossible to agree with the unqualified statement that full and fine vessels could be built with the same kind of scantlings. He only consented to sign the report on the understanding that such an assumption was not allowed. His colleagues were all against him, but they finally agreed that it could not be absolutely decided without experiments at sea. He hoped that they would get better results with the new registering instrument. With the old instrument it was always very difficult to read movements in bad weather. He hoped Sir Eustace d'Eyncourt would have the new instruments fitted to an Admiralty vessel and tried at sea to enable them to get some further information. If that was combined with the information which Mr. Kent was gathering it would be of great help in the final solution of the problem as to whether fine or full vessels were most seriously stressed at sea.

Mr. Alexander thought that the question of proportion was much more important than that of fineness of form. The bending moment of a vessel was made up of two parts, the part in still water and the part in waves. No matter how the vessel was loaded, the latter part was exactly the same; the range from hogging to sagging was exactly the same, and the oscillation across those two stresses would be the same. Whether the draught of the vessel was light or deep it did not alter that point of bending moment. Great care must be taken in using the factor 35 as a coefficient, because it applied only to vessels of normal proportions on beam and draught. In one vessel of which he had particulars the coefficient was as low as 25, and the whole ship had to be altered as a result of that discovery. He hoped that Mr. Champness would find time later on to deal with the dynamics of stresses. The chief value of those calculations was to enable the registration societies to diagnose correctly what was the cause of damage in stressed ships, to tell whether stresses were constructional or local.

Mr. W. R. G. Whiting communicated a written criticism of the paper. He said that he hoped that Mr. Champness would add to his diagrams on Plates II. and III. the curves of bending moment and shearing force for the still-water condition. It was in these that the bulk of the differences between one type and another originated, since the bending moments, &c., due to the statical wave were independent of the still-water moments and largely independent of the draught. The two systems were merely additive, and when superimposed tended to mask what might be obvious, namely, the price which had to be paid for extreme and ill-considered distribution of weights. The true criterion of any alternating stress imposed on material was the range of variation above and below the steady load value, and these figures would be readily found if this additional information could be given. Reliable data was required as to the way in which a ship's 'midship section stood up to known loadings. Experiments at sea were, in the first instance at any rate, of little value, because of the indeterminate nature of the loading. Those carried out in dock, of which Sir John Biles' work on the Wolf formed the classic instance, were impracticable save in isolated instances. But in the case of cargo vessels, and especially in the case of tankers, very large and absolutely determinate changes of bending moment might be applied by loading filling tanks, and the corresponding changes of stress in various parts of the 'midship section could be directly observed. Such experiments, comparatively inexpensive, and with the conditions of the problem completely known and under control, would furnish the foundation on which researches at sea might be based, and would certainly remove many of the questions affecting the longitudinal strength of ships from the region of speculation to that of experience.

Mr. Champness replied briefly to the criticisms and added that he thought it would be a good thing if, in an Institution like that of the Naval Architects, in which owners and architects met on common ground, such experiments on sea-going vessels were initiated by the Institution itself.

The next paper taken was that by Professor C. E. Inglis, entitled "Some Special Cases of Two Dimensional Stress or Strain."

Two-dimensional Stress or Strain.

This paper embodied a purely mathematical discussion of the distribution of stress in very thin flat plates of various forms and variously loaded. From the general stress component formulæ the stress distribution in a flat plate of tapering width when subjected to pure axial loading was first deduced. Next, the distribution of stress was analysed when the same form was subjected to bending by couples applied at its ends in the plane of the plate. The third case gave the distribution when the plate was subjected to bending by a transverse force applied at its narrower end while the other was held *encastré*. By combining the results deduced under the second and third headings, the general case of bending by concentrated transverse loads was obtained. The fifth and sixth cases related to the bending of a semi-circularly curved beam of uniform depth by couples and by transverse forces respectively applied at the ends. As an example of the application of the results arrived at, the stress distribution was finally worked out for a centrally loaded U-shaped stirrup cut from a flat plate.

After the President had paid a tribute to the high theoretical value of the paper, a brief discussion followed, in which Messrs. C. P. Martin and G. S. Baker took part.

At the concluding session of the conference on April 7th, a paper on the "Economic Efficiency of Merchant Ships" was presented by Mr. John Tutin.

Economic Efficiency of Merchant Ships.

Taking as a general expression for the efficiency of a merchant vessel the formula :—

$$E = \frac{(\text{Freight earnings per annum} - \text{Charges per annum})}{\text{Capital invested}} \times 100$$

the author sought to extend it so as to introduce such factors as the cargo deadweight, the net tonnage and displacement, the first cost, the sea speed, the freight rate, brokerage and management expenses, tonnage dues, horse-power, cost of fuel, fuel consumption, insurance, wages, depreciation, length of voyage and number of days in port. The formula having been established in terms of these quantities, the author analysed it with the object of determining the relative importance of the various factors involved. He concluded that the factors giving most scope for improvement in the economic efficiency were :—(1) The adoption of liquid fuel; (2) the use of Diesel engines in place of steam; (3) the introduction of single-collar thrust blocks; and (4) the paying of increased attention to propeller design.

In the discussion, Dr. P. Hillhouse said great attention had been paid to the subject during recent years. There were two ways in which the problem of the economic ship might be investigated, the tabular method and the mathematical method. In the first method, by a somewhat tedious process, the shipowner was able to ascertain the probable economic value of a particular type of ship. As compared with the mathematical method, the tabular process had the advantage that it was possible to allow for the variation of horse-power with speed, and, indeed, other factors, in a way which was not possible with the mathematical method, and there was the further advantage of clearness and absence of mathematical symbols. The attempt to use a formula introduced a more rigid system, and there were items which affected economy of operation which were not amenable to mathematical expression. Broadly speaking, although Mr. Tutin had suggested an ingenious method of ascertaining by mathematics the relative importance of certain items, the tabular method would probably be preferred.

Sir Archibald Denny congratulated the author on his work, and said that it recalled some of his earlier days when he had made somewhat similar investigations. He believed the formula Mr. Tutin had worked out would be extremely useful in design, although it had to be borne in mind that owing to the special demands in connection with design made by many shipowners, the scope of application of the author's work might be somewhat limited.

The last paper on the agenda was "Recent Developments in Motor Lifeboats," by Mr. J. Rennie Barnett.

Motor Lifeboats.

This paper gave a description of two recent types of power-propelled Royal National Institution lifeboats. The first boat dealt with was a small 35ft. self-righting vessel designed to permit it to be transported on a carriage on land. This boat is stationed at Eastbourne, and is driven at 5.9 knots by a motor of 15 brake horse-power. A similar boat of lighter construction and higher speed is being laid down for an East Coast station. The second boat described by the author was the New Brighton vessel. This boat has a length of 60ft., and is driven by twin screws and two motors of 76 brake horse-power each at a speed of

* No. III. appeared April 21st.

CONDENSING PLANTS FOR ELECTRIC GENERATING STATIONS

(For description see page 457)

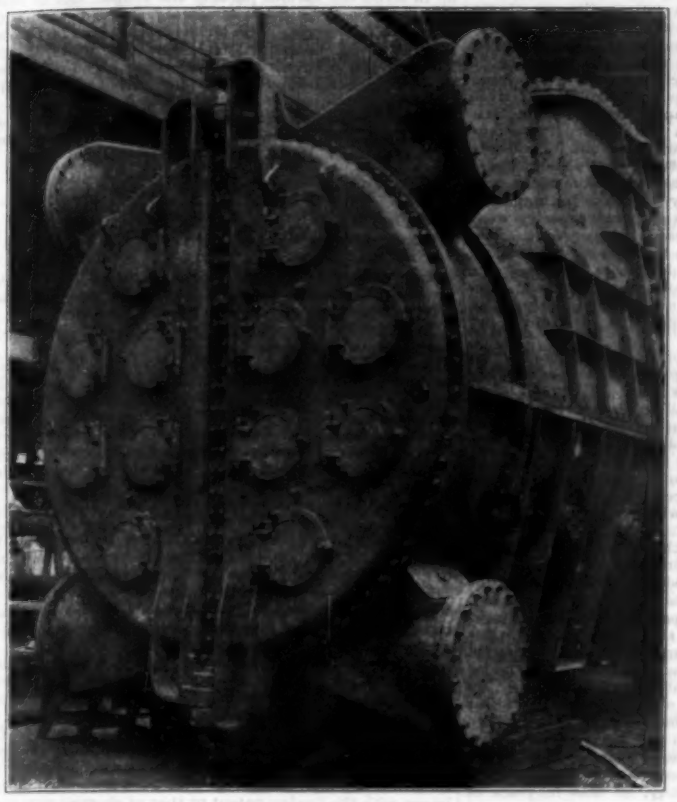


FIG. 152—HICK-HARGREAVES CONTINUOUS SERVICE CONDENSER

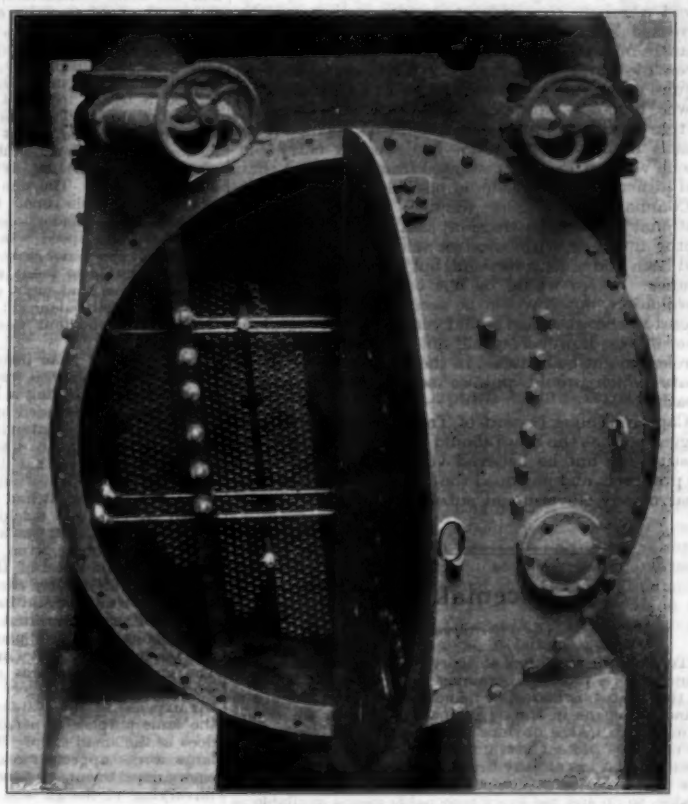


FIG. 153—BROWN-BOVERI CONTINUOUS SERVICE CONDENSER

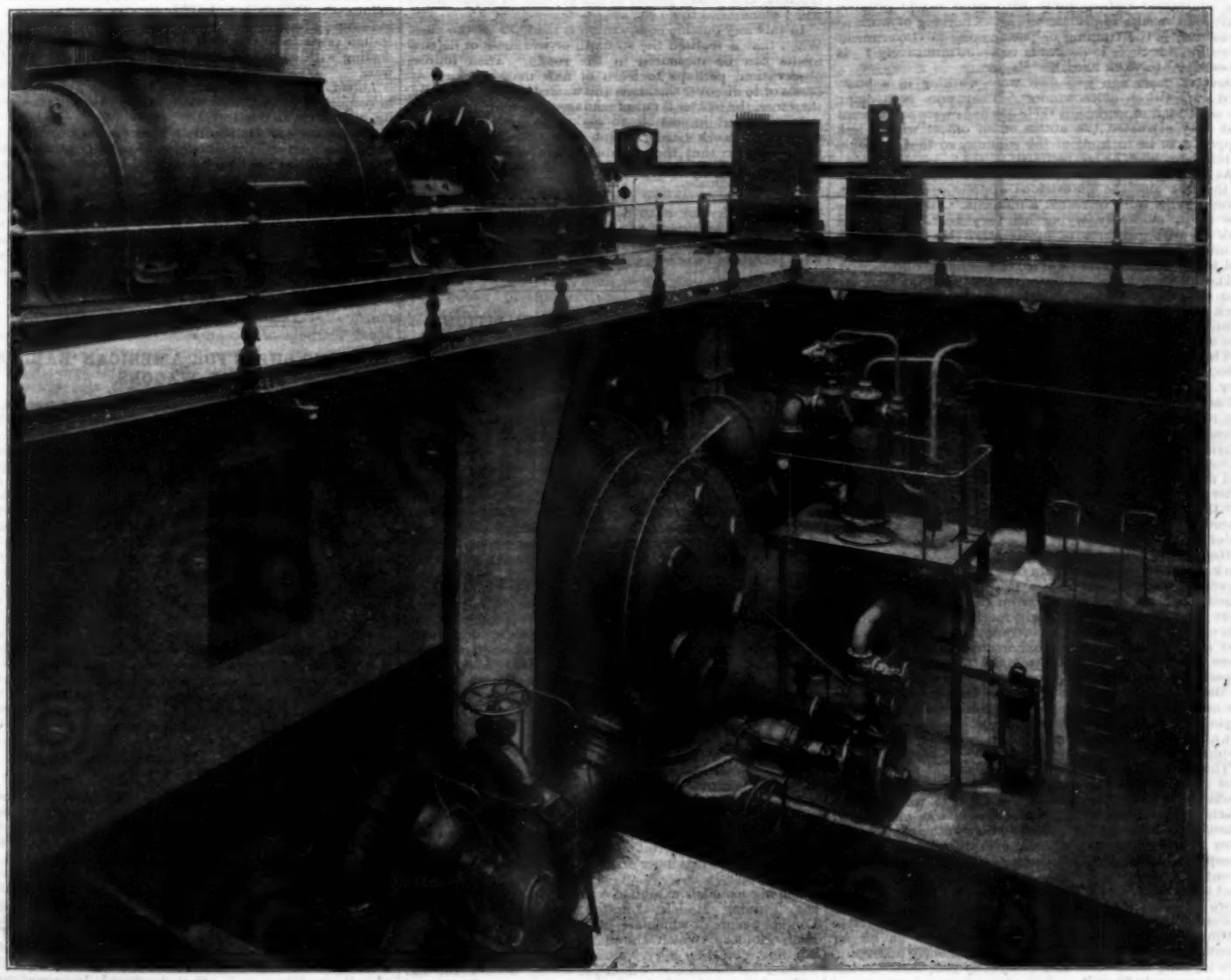


FIG. 154—A 12,000-KILOWATT TURBO-GENERATOR AND HICK-HARGREAVES CONDENSING PLANT

9.75 knots. She is constructed with a double skin of teak and with transverse and longitudinal bulkheads of steel.

Mr. E. W. Blocksidge said that the importance of the lifeboat service would be generally acknowledged, in spite of the fact that there had during recent years been a steady decline in the number of lives saved through the lifeboat service owing to the increased standard of efficiency in life-saving appliances on board ship, and to the aid in rescue work given by wireless telegraphy. What seemed to be required under present conditions was a fleet of large-power lifeboats equipped with wireless apparatus, so that ready communication could be effected with vessels in distress, and the boats could carry out rescue work at greater distances from the shore than had hitherto been considered possible.

Commander Douglas (deputy chief inspector, National Lifeboat Institution) said that the fitting of motor lifeboats with wireless telegraphy apparatus had been under consideration, but it was a question of finance. There would be not only the cost of the installation, but it would be necessary to employ an operator whose services would very rarely be required. The subject, however, would not be lost sight of, and wireless might be installed in the large-power cruising boats which would put to sea regularly in bad weather.

Captain Young (Board of Trade) said it had been suggested that the State should take over the Lifeboat Institution, but he believed voluntary effort was to be preferred, and he hoped the Institution would keep clear of any Government subsidy.

Pacemaking.

(*By a Correspondent.*)

To excel in any kind of sport or game requiring sustained effort, prolonged training to develop the faculties to the utmost, is known to be necessary. And one of the principal agents in training is pacemaking, or something akin, which makes obvious what progress is being made or measures present attainments in comparison with the ideal or what has already been accomplished. To improve, the sportsman must compete. He must know what he desires to do and use every reasonable means available to assist him. The same applies to those pastimes requiring more skill or judgment than strength.

In a recently published report the cost of labour for doing a certain amount of work in Government workshops was contrasted unfavourably with what would produce equivalent results in private works. Thinking of work as a pastime, is the training or pacemaking in Government shops inferior? Is it desirable to train intensively? Is it beneficial to work hard?

Several years ago two men were working in a boat-yard opposite an office window. They were both doing the same kind of work, but their methods were so different that they attracted the notice of an officer whose desk happened to be in front of the window, so that he could watch them when he felt inclined.

At first sight it seemed to be a case following the lines of the idle and the industrious apprentices. One man never left his work or rested a moment. All day long he was at it, evidently trying his very best. The other took life with greater ease, apparently. He did not seem to mind very much whether he built a boat or did not, and his foreman received advice to discharge him.

The foreman knew, and records proved, that the man who apparently slacked produced nearly twice as much work as the other. His every blow told exactly as it was meant; he wasted not a movement, made no mistakes. The other was always trying to retrieve his own muddles, and he was the one discharged.

So, in every case, the master of his craft makes it seem easy. But except in certain obvious cases—for example, billiards—popular judgment forgets this, and measures, not results, but commotion. In the example cited the officer judged first by the amount of commotion, but was convinced by the records and his subsequent personal investigation. The muddler was unsuited in his job, and no amount of training would rectify that. Could the other man have been persuaded to do still more? Perhaps, but there is a limit. Who knows what deep things he was planning when apparently resting? Thought absorbs a lot of energy.

Here is another case of a different kind. At a time when work was hard to get a certain firm contracted to machine several thousand pieces for a price. The estimate was based on the longest operation on each piece taking not more than three minutes. Eight machines were set up for this operation. Of course, as is common, it started slowly. But after several weeks of exhortation and despair not more than twelve an hour was the average. Then an experiment was tried. A young man who was reputed to be the finest turner in the shop was transferred to one of the machines. Rather a setback for him, but matters were explained openly and the premium bonus price per piece not altered. In some districts and periods the experiment would have failed.

This succeeded. In a few days his output was twenty-four an hour, while he gazed around with one hand in his pocket. Within three weeks the average from all the machines exceeded twenty an hour and was maintained when the expert was transferred to his own machine again. Now here the pace was set, and everything was in order, except probably incentive to try. If an operator conscientiously believes the task impossible in the time, until that belief is shattered it is impossible. Were the operators more exhausted or injured by producing more? Not discernably. But if it had not been for a very close estimate they would have been allowed to go on for months, or possibly years, working inefficiently and therefore injuring themselves and everybody else, none the less because nobody knew it.

Very frequently a small change in method or to machines is effective. It is an old story how "so-and-so" increased his output by changing driving pulleys at night so as to increase speeds a little without anybody noticing. But the following example is perfectly true, and it was not done in secret. An order was received by a small firm for large quantities of small parts to be assembled. When assembled the parts were riveted together. It was a sub-contract, and the main contractors, having done several hundred thousand, could assemble and rivet five units per minute for every three operators. Thus the standard of attainment was set. When the processes were laid out by the officers who managed the small works, knowing how it was already being done, they decided that four operators formed a better balanced group to assemble and rivet instead of three. This was on paper, before anything was actually performed. But when the performance commenced only three a minute were turned out. The three who assembled seemed, as expected, to have about equal amounts to do. The one on the riveting machine was working the whole time. Clearly, therefore, no improvement could be made unless the machine capacity were increased. Its speed was increased 50 per cent. The increase in speed not only made the riveting blows more frequent, but also made each blow more effective, and the result was that eight a minute were delivered. The group was well balanced; the machine set the pace so that each of the four was occupied fully without being distressed.

The following is an instance of a type common everywhere. Two machines were employed almost constantly in turning and drilling a hollow bolt. They were large machines, each attended by a full-rated man, both industrious. A new superintendent was appointed. He noticed these machines and had the tool set-up on one machine changed a little, so that drilling the core away was done at the same time as turning. Quite usual everyday practice this; but here it had not been tried. Two men were employed and two machines, where one was sufficient when the adjustment was made.

In every example given, once the observation was made and the significance of the facts noticed was properly understood and justly considered, to make a change for the better was easy and inexpensive. It may be inferred, therefore, that some kind of "pacemaking" in management should precede "pacing" the manual worker. But it is far easier to observe in the small than the large works. The greater advantages and facilities which the larger works affords are largely or entirely whittled away by the expense of the system and officers required to effect the same purpose as personal observation and knowledge does in the small shop. Only in one way probably can a large works approach reasonable efficiency; that is by each department producing continuously a product unvarying in design and quantity, so that in years of gradual improvement everywhere imperfections and waste are more or less eliminated. Even then, to guard against too great complacency, estimates would have to be regularly and systematically obtained from other contractors, and orders placed at the expense of departments when economical to do so.

In this way outside competition is made to set the pace. When that is realised the strength or weakness of departments can be measured in the rough. Then follows observation, perhaps to learn of new machines or processes or to discover slackness and wasted effort. Primarily, therefore, the matter is one of management being improved.

It is almost impossible to make the direct producers consciously work harder. But it is frequently possible to arrange so that they produce more without suffering from the bad effects of overwork, as the few examples mentioned indicate.

A Government factory has this inherent disadvantage: it is quite easy for it to have, in form, an extravagant amount of pacemaking; but, in spirit, even a little is hard to introduce, unless forced by competition on equal terms with private enterprise.

BRAZILIAN CENTENARY EXHIBITION.

An opportunity for British manufacturers and merchants to extend and open up new business in South America is offered by the Brazilian Centenary Exhibition, to be held at Rio de Janeiro from September 7th to December 31st next, in celebration of the centenary of Brazilian independence. The British section is being organised by the Department of Overseas Trade.

Realising that many British firms which could do business there cannot at present afford the sum necessary to exhibit actual goods on the scale required, the Department has made arrangements for the display of goods by means of models, cinema films, lantern slides and lumiere plates. Lumiere plates, which are coloured reproductions on glass, lend themselves particularly well to the display of such articles as fabrics, jewellery, pottery, &c.

With this end in view the Exhibitions Division arranged a small exhibition at its offices of modern advertising novelties. Amongst them were photographic transparencies in natural colours. These transparencies vary from about full plate to 5in. by 4in., and were arranged in a sort of picture gallery along the level of the eye in semi-darkened rooms. The method is particularly suitable for the jewellery trade in that no risk is involved and jewellery reproduces in a very remarkable manner. The examples of pottery, glassware, metal ware, furniture, fashions and certain fabrics were also beautiful and successful for their purpose. It is obvious that the process is less suitable for machinery, motors and the like. The name of the firm is entered over the group of photographs.

In another case photographs in natural colours were projected on to a screen and changed automatically. A series of such plates was shown on a model projector, and one hundred could be run off a single belt giving exposures of five seconds or longer with obscuration for about two seconds.

Amongst models exhibited was a fine example made by the Twining Models, Limited, of Northampton, the London agents of which are Bassett Lowke and Co., 112, High Holborn, which shows a complete works in the minutest detail on a very small scale. A model railway worked by electricity, which costs only £100–£150, and which is capable of development not only for travel purposes but to attract attention to any commodity which may be carried as a load, was also shown. It is the work of W. H. Jubb, Limited, of Sheffield, and appeared at the British Industries Fair this year. A geographical model, which is a section of a model of the world on Mercators projection, and will form part of the British section in the International Exhibition about to take place at Rio de Janeiro, attracted attention. The idea is to light up in series the various parts of the Empire and to show their connection by means of moving models of boats with Brazil and its ports. This model is the work of Charles Ledwidge, 15, Glazebury-road, London, W. 14, Model Maker to the Admiralty and War Office. The completed world model, showing the Empire routes, will be 22ft. square.

There was also shown a new illusion process known as the "Lu-pal" illusion development, and the illuminated signs of the K.F.M. Engineering Agencies Company.

FOREIGN PATENT LAWS.

The very rapid change of foreign patent laws at the present time needs to be watched by those inventors whose activities are not necessarily limited to this country.

Among these changes there should be noted those made in the countries referred to below.

Australia.—An amending act has been passed, according to which the existing Australian Acts are to cover the territory of New Guinea, presumably without any further application having to be lodged. No notice of the actual date from which this extension shall take place has yet been received. The term of the patent and the term of any possible prolongation have been varied in a manner similar to the Britian law, so that an Australian patent now runs for sixteen years provided fees are paid and its maximum period of prolongation is ten years. Provisions are made for application to the Court for an extension owing to war losses. Another addition has been made referring to applications made under the International Convention. This corresponds to the British Act of 1914, which is commonly overlooked, namely, that such applications may be made by the legal representative or assignee instead of by the original applicant.

Esthonia.—This law has now apparently been settled and is to a large extent based on the French law, in that it appears that publication in a country foreign to Esthonia will invalidate a patent in that latter State. Patents of invention are granted at the request of the applicant for a period up to fifteen years, and as in this country the date runs from that of the application; but in the case of inventions first patented outside the State, the Esthonian patent lapses with the foreign patent or that of shortest duration, should there be more than one. Provisions are introduced for requiring the working of the invention in Esthonia, a period of three years being given to enable this to be carried into effect. The law on this point substantially follows the British Act of 1907.

India.—Changes are taking place with reference to Indian practice in connection with the time available for dealing with cases which have been delayed owing to the war.

Latvia.—The old Russian law has been amended both in respect of patents and trade marks in connection with its application to this territory.

Rhodesia.—An Act has now been passed providing for the grant in Northern Rhodesia of patents to those who have already applied for or secured patents in Southern Rhodesia. The term limiting the patent is fourteen years from its date and renewal fees are required. No search is involved to determine the permissibility of the claims. Provisions are inserted in the Act for petitions for the revocation of a patent under certain circumstances and it is provided that a patentee may be caused to supply a model of his invention on demand by the Administrator on payment of the same.

THAWING SHEDS FOR AMERICAN RAILWAY COAL WAGONS.

The unloading of coal and ore from the wagons of American railways in winter is often hampered by the freezing of the contents into practically a solid mass. In order to provide against delays of this kind at the South Amboy coal terminus of the Pennsylvania Railway—upon which terminus a number of large public utilities are dependent for their coal supply—two large thawing sheds have been constructed. Each of them is a concrete structure 450ft. long, having two lines of rails, each accommodating ten large cars or coal wagons. When the twenty wagons have been shunted into the shed, the doors are closed, and blowers force a current of air over steam radiators and thence through ducts beneath the floor, from which there are outlets 6ft. apart beneath the cars. The air, heated to 200 deg. or 250 deg. Fah., soon begins to thaw the frozen mass. The thawing process can be accomplished in from one to twelve hours, according to the extent of freezing, but the average time is about three hours. From each shed the cars move by gravity to the two dumping machines, which raise and tilt the wagons so as to discharge the coal into barges for delivery at various points on New York harbour.

The cause of instability in Invar steel has recently been discovered by M. Guillaume, who has also found a means of practically eliminating it. This is achieved by the addition of a small proportion of chromium, the result being that the extent of the instability, as measured by the change in length after 100 hours at a temperature of 100 deg. Cent., is reduced to one-tenth of its former value, while its low coefficient of expansion remains unchanged. A further addition of chromium will entirely eliminate instability, but results in a higher dilatability. This new alloy is susceptible to the thermal and mechanical treatments which are made use of to reduce the expansion of ordinary Invar steel, but their effect is less pronounced in its case.

A Seven-Day Journal.

The Rowan Collision Actions.

JUDGMENT has now been issued by Lord Anderson in the Scottish Court of Session in the several actions arising out of the sinking of the Laird Line steamer Rowan off the Wigtonshire coast on October 9th last. It will be recalled that the Rowan first collided with the United States Shipping Board's vessel West Camak, and then, fifteen minutes afterwards, was run down by the Clan liner Clan Malcolm, with the result that the Rowan sank, and a considerable loss of life occurred. Four actions for loss and damage arose out of the disaster. The Laird Line sought to recover £100,000 as damages against the owners of the West Camak, on the ground that she had inflicted mortal injuries on the Rowan. This claim, however, was subsequently modified to one for £11,000 on the footing that the injuries to the Rowan caused by the West Camak were not fatal. The owners of the West Camak denied that the first collision was the fault of their vessel, and counter-claimed for £8000 with respect to the damage caused to her by the Rowan. The Laird Line, alleging that the sinking of the Rowan was the result of the second collision, then brought an action against the Clan Line for £100,000. Finally, the Clan Line counter-claimed for £7500 against the Laird Line for the damage inflicted upon the Clan Malcolm. In his judgment Lord Anderson held that the first collision was caused by the faulty seamanship of the Rowan in proceeding at practically full speed in, or in the neighbourhood of, fog, and by the improper manœuvring of the vessel after the West Camak had been sighted. The Rowan, after the first collision, was, he held, not in a sinking condition, and could have been salved. As to the second collision, his Lordship found that the liability rested two-thirds with the Clan Malcolm for failing to reduce speed to a sufficient extent upon entering the fog, and one-third with the Rowan for not giving the prescribed signals that she was out of control and in distress.

Port of London Improvements.

IN conjunction with and in extension of its original scheme of improvements at Tilbury, the Port of London Authority is now seeking parliamentary powers for the execution of additional works involving an expenditure of nearly £1,000,000 and having for their object the provision of increased passenger traffic facilities at the port. Included in the proposed new works are the construction of a floating landing stage connected to the shore by two main bridges, the provision of conveyors for handling luggage, and the erection of a new baggage hall. By means of these improvements the transference of passengers from the liners to the shore and their transportation to London would be considerably expedited.

The Spread of Wireless Telephony.

MUCH attention is at present being paid in this country to the development of wireless telephony as a means of disseminating broadcast information of general interest, speeches, proclamations, concerts, and other matter. According to Mr. Godfrey Isaacs, the Marconi Company is prepared to let out on hire or sell—the former preferably—a large number of receiving sets that would bring wireless telephony within the reach of many homes and offices. In America the subject has gone ahead with remarkable rapidity within recent times, over half a million receiving sets having been distributed within a year. In this country, on the other hand, Government restrictions on the use of wireless apparatus have prevented any considerable development, not more than 7000 amateurs holding licences for the use of receiving apparatus and 280 for transmitting. The service requirements in the way of wireless and the difficult question of deciding who is to control the broadcasting stations and what matter is to be distributed are at present engaging the Government's attention. A pronouncement on the attitude to be adopted is expected shortly from the Postmaster-General.

Aircraft Manufacture in Germany.

ON and from the 5th of next month Germany, under the terms of the Peace Treaty, will be permitted to resume the manufacture of commercial aircraft. On that date, too, the Inter-Allied Air Commission will be replaced by the Inter-Allied Guarantee Committee. The Commission began its work early in 1920, under the control of Air Commodore E. A. Masterman, and consists of some two hundred British, French, Italian, Belgian and Japanese officers. It is said to have been responsible for the destruction of 14,800 aeroplanes, 29,550 motors, 11 airships, and 500 aeroplane and airship sheds. The new Committee will consist of thirteen officers and twenty-eight non-commissioned officers, and will have for its principal task the enforcement of the ban against the manufacture in Germany of military aircraft. Under this heading will come all single-seater machines with engines of more than 60 horse-power, machines which can fly without a pilot, machines provided with protective armour or capable of being equipped with armament, machines which, with full cargo, can rise to more than 13,000ft., or which, with full cargo, can fly at 6500ft. at a speed in excess of 106 miles an hour. Rigid airships of more than 1,060,000 cubic feet capacity, semi-rigids of more than 883,000 cubic feet capacity, and non-rigids of more than 706,000 cubic feet capacity will be considered as military vessels.

Devonshire Lignite Beds.

A WEST COUNTRY contemporary reports that work is about to be begun upon the sinking of a mine shaft to reach the lignite beds at Heathfield, near Teignmouth, Devon, a deposit in which, if we remember aright, Herr Hugo Stinnes was greatly interested in the days before the war. The shaft is to descend to a depth of about 500ft. The lignite will be treated by distillation for oil and other products, the residue being disposed of in the form of briquettes. Distilling plant, capable of dealing with 100 tons of lignite per day, is to be erected at the outset. The work is being carried out by the enterprise of the Wilson Syndicate, of London.

Tar Pollution of Fishing Waters.

THE publication is shortly expected of an interim report prepared by a joint departmental committee of the Ministries of Transport and Agriculture upon the question of damage caused to fisheries by tar pollution from road rain washings. As a result of experiments at Alresford, Hampshire, the Committee has found that the maximum toxic effect upon fish of the rain washings from a tar-treated road occur at two distinct periods, namely, when the road has been recently tarred, and when its surface is disintegrating. It is suggested that highway authorities should give preference to an asphaltic bitumen free from tar products for treating roads draining directly into fishing waters.

A Large Engineering Combine.

A LARGE and important combination of engineering firms has just been registered under the title of the Power and Transport Finance Company. The firms represented in the combine are Cammell Laird and Co., Limited, Sir Wm. Arrol and Co., Limited, the English Electric Company, Limited, the North British Locomotive Company, Limited, John Brown and Co., Limited, and the Prudential Assurance Company, Limited. The board of directors consists of Mr. W. L. Hichens (Cammell's), Sir John Hunter (Arrol's), Lord Meston and Mr. P. J. Pybus (English Electric), Sir Hugh Reid (North British Locomotive), Mr. John Sampson (John Brown), and Sir George May (Prudential). The object of the company is to undertake and, if necessary, to finance large engineering contracts for railways, rolling stock, power stations, docks and harbours, and, in general, all other aspects of power production and transport work. Headquarter offices for the new company have been established in Kingsway, London. The initial capital is a quarter of a million sterling.

An Important Dye Discovery.

SOMETHING in the nature of a revolution in the dyeing industry seems to be indicated in the announcement made by Professor A. G. Green regarding the properties of the ionamine dyes that have recently been discovered by the laboratory staff of the British Dyestuffs Corporation. These dyes are the outcome of a research into the dyeing of acetyl silk, a strong and beautiful form of artificial silk produced by the British Cellulose Company, the manufacture of which has hitherto been impeded by the difficulty of dyeing it in fast shades. The new dyes are stated to have a peculiar affinity for acetyl silk, but to be without effect on cotton. Consequently, a mixed fabric of cotton and acetyl silk can be treated in a single bath composed of an ionamine dye and another such as chlorazol blue, which has an affinity only for cotton, with the result that each fibre will select its own dye. It is possible, too, by subsequent chemical operations, still further to modify the final colour state of the fabric as a whole. The advantage to be gained by producing a parti-coloured effect on a mixed fabric by means of a compound bath rather than by separate dyeings of the threads before weaving is no doubt considerable, but is not obvious to the uninitiated.

Report on Trade Boards.

ON the ground that the operation of the boards constituted under the Trade Boards Acts was responsible for much unemployment and was handicapping effective competition against the foreigner, an agitation for the reform of the Acts was started in the Midlands about three years ago. As an outcome of the representations made, the Minister of Labour appointed a Committee, under the chairmanship of Viscount Cave, to inquire into the working of the boards, and to make recommendations as to how the Acts might advantageously be altered or modified. That Committee has been at work since last September, and has now presented its report. It finds that while there has been some exaggeration in the statements made concerning the effect of the Trade Board system on industry, there are grounds for the allegation that certain of the boards have contributed to the volume of depression and unemployment. It urges that the Acts of 1909 and 1918 should be repealed and a consolidating Act with the necessary amendments substituted for them. The alterations proposed cover a large amount of detail, but in general they are such as to make the Trade Boards bodies charged with the duty of preventing sweating rather than instruments for the public regulation of wages throughout the industries concerned, as they have in some instances come to be regarded since the passing of the second Act.

The Late Captain Carus-Wilson.

THE wireless world has lost a most promising and enthusiastic worker by the death of Captain Carus-Wilson, M.C., Royal Corps of Signals. He was the second son of Professor Carus-Wilson, the late occupier of the Electrical Engineering Chair at McGill University, Montreal. Although only twenty-five at the date of his death, he had had a very varied experience since he passed into Woolwich in February, 1914, as a prize cadet second on the list. In November of the same year he received his commission in the Royal Engineers, and thereafter served continuously during the war in France, Belgium, and Italy. He gained the Military Cross for services rendered at the Battle of Messines, on which occasion, for seven days, under heavy shell fire, he used for the first time in action an improved form of wireless signalling. During the summer of 1918 he commanded the Signal Company of the 9th Division, and after the march to the Rhine lectured on electricity to the British troops of occupation. In 1919 he was selected by the War Office to attend l'Ecole Supérieure d'Electricité at Paris. After winning the diploma in radio-telegraphy of the University of Paris and passing out first among all the foreign officers who completed the course, he was attached to the Wireless Headquarters Staff in London. Subsequently he was engaged on original research at Woolwich, and was later on appointed to represent the War Office in connection with the setting up at Cairo of the first link in the Imperial wireless chain. He died at Brighton on Sunday of tuberculosis contracted on service.

The Shipyard Strike.

IT is very satisfactory to be able to report that one, at least, of the labour disputes at present afflicting the country has this week been brought to a state of agreement between the representatives of the contending parties. When the conference between the Shipbuilding Employers' Federation and the Negotiating Committee of the Shipbuilding Trade Unions Federation broke down three weeks or so ago, it was intimated by the employers that they would be quite ready at any time to meet the union representatives and to consider any proposals that might be made. No steps, however, were taken by either side towards a resumption of negotiations until Friday of last week, when the union representatives approached the employers with a view to reopening discussions on the proposed reduction of 16s. 6d. in the war bonus. A joint conference was arranged for Tuesday, and as an outcome an agreed basis of settlement was arrived at which the union representatives undertook to recommend their members to accept. The terms previously rejected by the men were a reduction of 10s. 6d. per week on March 20th, and of a farther 6s. per week on April 26th. The agreement now arrived at covers, it is understood, a reduction of 10s. 6d. per week from the date of resumption of work, followed by two additional reductions of 3s. each at short intervals.

The Engineering Dispute.

WHILE the shipyard dispute has undoubtedly taken a turn for the better, the situation with respect to the lock-out in the engineering industry has grown worse. The three groups of unions other than the Amalgamated Engineering Union, after farther discussion, decided to adhere to the attitude they had adopted with regard to the question of material changes in workshop procedure, the point on which the negotiations with the employers broke down on Good Friday. As a result, the employers posted notices in all the federated workshops on Tuesday cancelling the suspension of the earlier notices, and making the lock-out effective as from May 2nd. On Friday the Amalgamated Engineering Union opened informal conversations with the employers, but no progress was made towards reaching an understanding on which negotiations could be resumed. Efforts are now being made to induce the Government to set up a court of inquiry under the Industrial Courts Act.

The Fullagar Oil Engine for Land Purposes.

THE recent rapid development of the Diesel oil engine for the purpose of marine propulsion has perhaps somewhat obscured its equally important application in the electrical generating station, where, on account of its peculiar ability to deal economically with varying loads, it is now widely used. The reliable operation of stationary Diesel engines of comparatively small horse-power, has brought about an increased demand for engines of relatively higher power, which demand has up to the present largely been met by continental makers. With the development of the Fullagar oil engine for land purposes, it becomes possible for the British manufacturer to offer engines of considerably larger powers than before.

We were recently invited by the English Electric Company, Limited, to visit its Willans Works at Rugby, so that we might inspect the first engine which it has designed and built on the Fullagar system. It may be stated that the English Electric Company, Limited, possesses the exclusive world rights for the development of the land type Fullagar oil engine, and is in a position to grant licences to suitable firms which desire to take up the manufacture of the engine for land purposes. A little over two years ago we described the marine type of Cammellaird-Fullagar oil engine,* and later† we gave an account of the successful trials of that engine in the motor ship Malia. The problem of applying the Fullagar opposed-piston principle to the land engine differs from that of the marine engine, for whereas in the marine engine a slow speed is desirable on account of propeller efficiency and manœuvring, in the case of the land engine a high-speed engine is cheaper to build, and smaller in size, and, with increased speed, the size and cost of the electric generator is correspondingly reduced.

Before describing the engine, it is of interest to note the saving of space effected by the Fullagar construction, which is clearly shown in the engraving, Fig. 3. For purposes of comparison, we contrast the size of a three-unit Fullagar engine designed to develop 1125 brake horse-power at 250 revolutions per minute with a standard 500 brake horse-power four-stroke cycle Willans engine of compact design. It will be seen that the Fullagar type permits of an engine of more than double the horse-power being accommodated on almost the same amount of floor space. It is true that the cylinders of the Fullagar engine stand higher than those of the four-stroke cycle engine, owing to the opposed-piston construction, but, nevertheless, the head room required is actually smaller; that is, the space required to withdraw the piston and connecting-rod from the cylinder of the 500 brake horse-power engine and to raise it clear of the cylinder cover studs is actually more than that required for withdrawing the pistons from the Fullagar engine. The oblique rods certainly require extra head room if they are lifted by the crane hook, but in practice it is found that they can be conveniently removed by attaching a light fitting to the crab of the crane, and their extra length really need not be taken into consideration.

The engine, which we saw running and which is illustrated by the engravings and sectional drawings accompanying this article, is shown on the test bed in Fig. 1. It is directly coupled to a 500-kilowatt generator which takes part of the works load, and by this means it has been possible to carry out extensive trials. Designed to give an output of 750 brake horse-power when running at a speed of 250 revolutions per minute, the engine is of the two-unit type; that is, there are two pairs of cylinders, each 14in. in diameter, with a piston stroke of 16in.

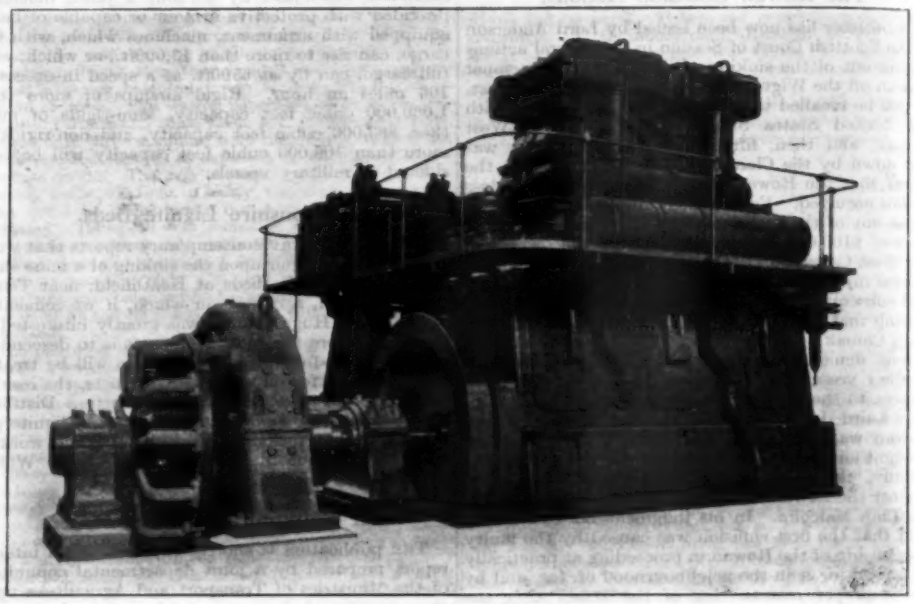


FIG. 1—ARRANGEMENT OF ENGINE ON TEST BED

On seeing the engine, we were at once impressed by the very robust construction of the bed-plate and crank case, which has been made possible by adopting a completely enclosed design of engine. The marked absence of vibration which we noted is no doubt due in a large degree to the ample proportions and strength of these parts. The cylinder jacket castings are secured to the machined top of the crank case, and, in addition, they are bolted together at the centre. As will be seen from the sectional arrangement in Fig. 2, the cylinder casings are provided with exhaust and scavenge air belts, which communi-

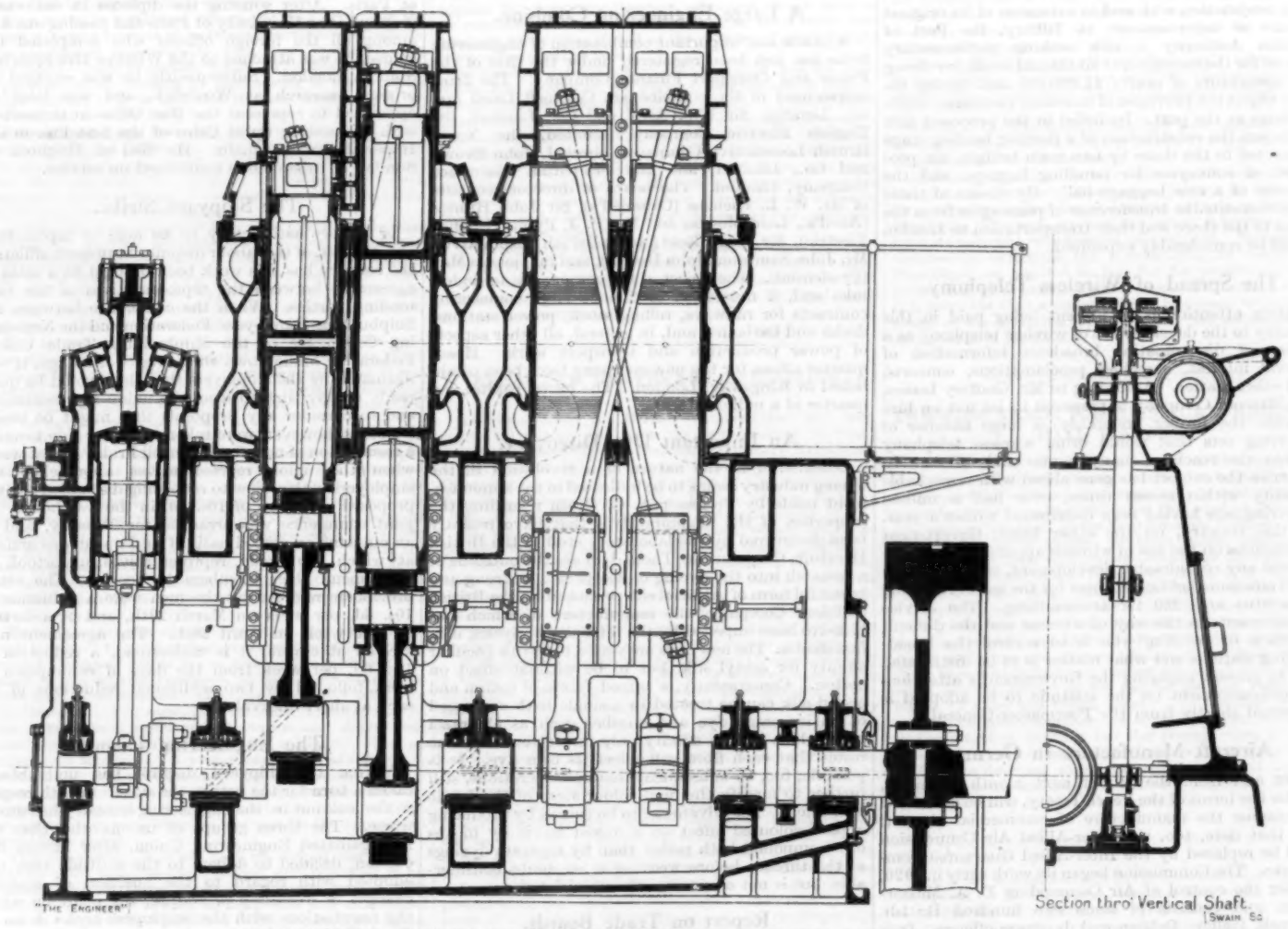


FIG. 2—SECTIONAL ELEVATION OF 750 BRAKE HORSE-POWER LAND TYPE FULLAGAR OIL ENGINE

* See THE ENGINEER, January 30th and February 6th, 1920.
† See THE ENGINEER, October 7th, 1921.

cate with the ports in the liner. The liners are fitted from the top, and are provided with the usual means of allowing for downward expansion. Gland rings are fitted to each end of the liner and a lubricating device is provided, whereby oil is delivered through capilliary holes at fixed distances around the liner outlets on the oil-cooling and water-cooling systems, which discharge into open tundishes fixed to the crank case. An indicating attachment is provided on each of the inspection doors, and when not in use, this attachment is protected by a cover. The vertical shaft and the governor gear is accommodated

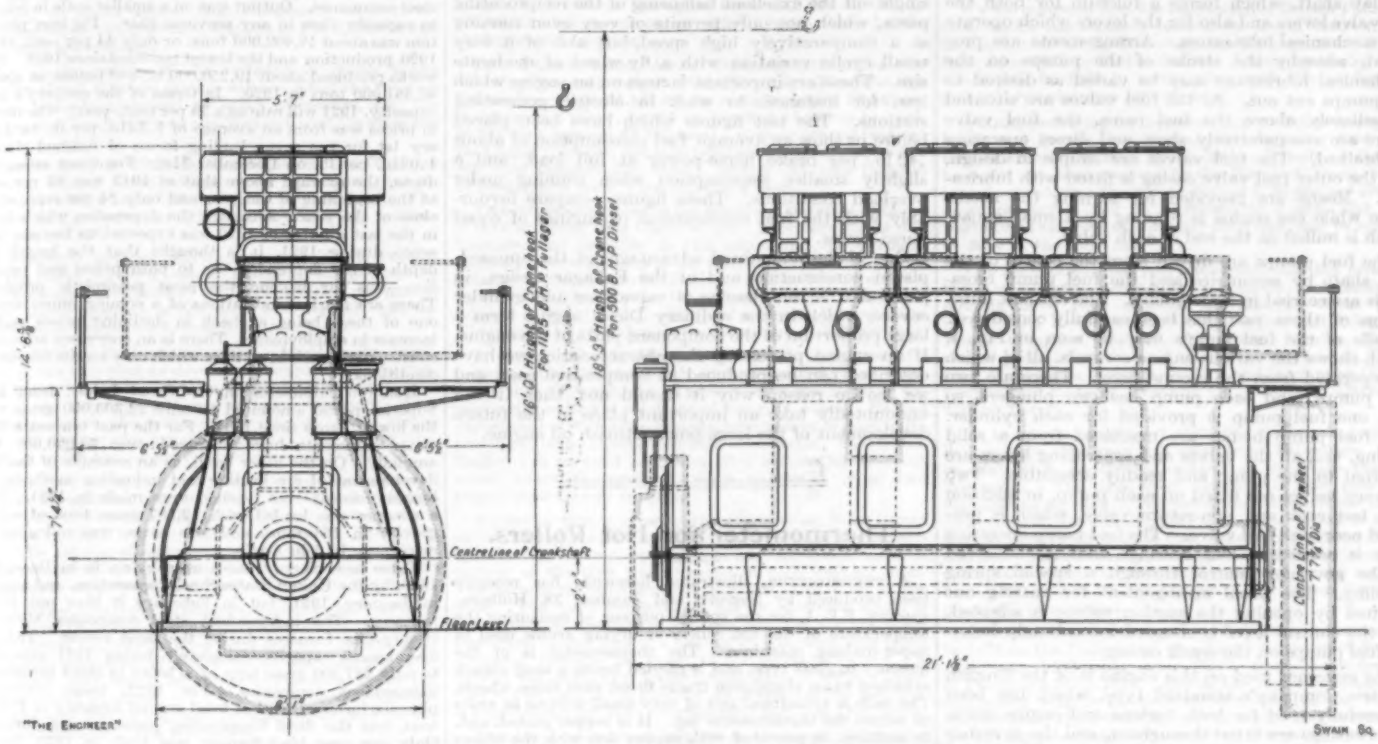


FIG. 3—COMPARISON BETWEEN 1125-B.H.P. FULLAGAR ENGINE AND 500-B.H.P. STANDARD DIESEL ENGINE

circumference. The oil is introduced between the second and third rings of the piston, and efficient lubrication is thereby attained.

The upper part of the cylinder casings carry the supports for the upper slippers of the diagonal rods, which are enclosed so as to form scavenge pumps. in the crank case alongside the fly-wheel, and the compressor with its group of intercoolers is arranged at the opposite end of the engine. Fig. 5 shows this part of the engine in detail. The air compressor is of the three-stage type, intercoolers being fitted between each stage. The vertical intercoolers on main scavenging air belt at an initial pressure of about 2 lb. per square inch. The supply of air is controlled by a butterfly valve operated by a hand lever affixed on the near end of the crank case underneath the platform ladder. This control admits of the pressure being regulated for any desired load. The arrangement also has the advantage that all the air required for the engine is entrained at one point. This is important for engines which may have to work in dusty situations, as it permits of a simple and effective filtering device being fitted. The air intake as at present arranged is situated on

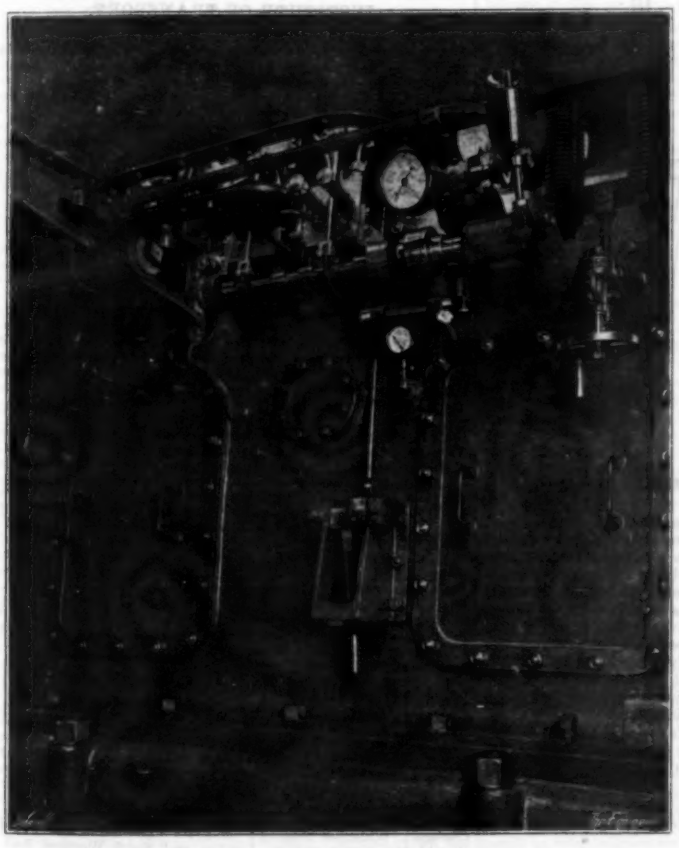


FIG. 4—FULLAGAR ENGINE CONTROL STATION

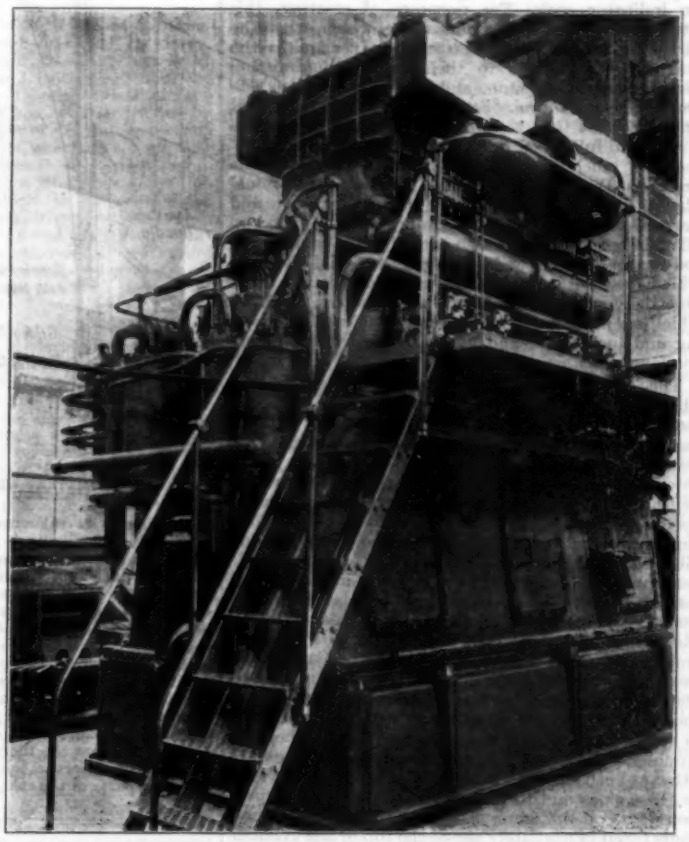


FIG. 5—END VIEW OF 750-B.H.P. FULLAGAR ENGINE

Valve boxes are arranged on the sides of these chambers, and the design of the valve boxes and scavenge air mains is such as to brace firmly together the upper part of the engine. Fig. 1 shows a view of the back of the engine. The arrangement of the scavenge air and exhaust systems may be noted, also the provision which is made for visible controlled the near side of the engine are the high-pressure and intermediate-pressure coolers respectively, while those on the far side are the first-stage intercoolers, which are in duplicate and are arranged in parallel. A separate cooling water service is provided for the compressor and intercooler system. The air for the first stage of the compressor is taken direct from the the front side of the engine beneath the valve boxes of the scavenge air pumps and midway between them. The substantial and roomy platform which is carried around the front and back of the engine and over the fly-wheel allows of ready access to the upper parts of the engine, as well as to the mechanical lubricators, the valve gear and the cams. Views of the front of

the engine taken from the platform and reproduced on page 470 show these parts in detail. The horizontal cam shaft runs along the entire length of the engine, and is supported in ring-lubricated bearings, which are carried by stout brackets cast on to the cylinder casings. At the back of the cam shaft bearing an additional bearing is provided to support the lay shaft, which forms a fulcrum for both the fuel valve levers and also for the levers which operate the mechanical lubricators. Arrangements are provided, whereby the stroke of the pumps on the mechanical lubricators may be varied as desired or the pumps cut out. As the fuel valves are situated immediately above the fuel cams, the fuel valve levers are comparatively short and direct operation is obtained. The fuel valves are simple in design, and the outer fuel valve casing is fitted with lubrication. Means are provided for turning the needle valve while the engine is running by a small square which is milled on the end of each valve.

The fuel pumps are driven from the centre of the cam shaft by excentrics and the fuel pump crossheads are carried in large guides. The efficient lubrication of these parts has been carefully considered. Details of the fuel pumps may be seen in Fig. 4, which shows the various engine controls, all of which are operated from the ground level. There are two fuel pumps, and each pump has two plungers, so that one fuel pump is provided for each cylinder. The fuel pump bodies are machined from a solid forging, and all the valves and controlling levers are external to the pump and readily accessible. Two delivery valves are fitted on each pump, in addition to a test cock and non-return valve, which is provided near each fuel valve. The fuel pump operating shaft is carried in ball bearings, and is connected to the governor control through a special spring coupling. The usual arrangement for cutting out the fuel by opening the suction valves is adopted, and the control lever is situated immediately below the fuel pumps on the crank casing.

The governor used on this engine is of the English Electric Company's standard type, which has been successfully used for both turbine and engine work. Ball bearings are fitted throughout, and the governor is very sensitive, and maintains very close speed regulation. Hand speed control is fitted, and is operated by means of a hand wheel, furnished with a suitable locking device and situated to the right of the fuel pumps on the crank case. The method of starting calls for mention, as the system adopted is a particularly neat one. On the opposite side of the cylinder casing to the fuel valve and at a point diametrically opposite to where the fuel valve enters the liner wall, a fitting is provided which serves the triple purpose of a starting valve, a relief valve and an indicator cock. For purposes of starting, this fitting is provided with a pilot valve, which, when the air is turned on at the starting receiver, raises the starting valve levers to their cams by admitting air pressure to a piston, and at the same time sets the engine in motion. Starting air is thus admitted at the correct time to two cylinders, and the engine runs up to full speed in a few seconds. The arrangement is much simpler than that in use with the ordinary Diesel engine. Fig. 2 shows a sectional elevation of the engine, with the compressor and vertical shaft drive. Forced lubrication is fitted to all main bearings, and is also carried to the connecting-rod top and bottom ends. There is a special oil pump which draws its supply from an underground tank, and delivers through filters and coolers, both of which are fitted in parallel, thereby facilitating cleaning and inspection, and at the same time reducing frictional resistance.

The main pistons are cooled by means of oil, which is transferred from the stationary to the moving part of the engine by means of a slot extending along the whole face of the crosshead shoe, which coincides with a hole in the guide. It then passes through the crosshead and into the piston, where deflecting plates are fitted to direct its flow, and it leaves the piston through the other guide. When running on full load, the temperature of the cooling oil at the discharge was comparatively low, indicating cool running of the engine. Recent investigations into the question of heat flow in piston crowns showed conclusively that the heat was greatest where the burning fuel impinged directly on to the piston crown. In the Fullagar engine the fuel is sprayed in a fan-like stream in a direction parallel to the two piston crowns, and it does not directly impinge on them. The method of injection may be connected in some manner with the absence of piston heating troubles. As previously mentioned, gland rings are fitted at both ends of the liners, and access is provided to these rings and to the pistons through the inspection doors on the crank case, and also through small doors fitted immediately above the top of the cylinder casing. Referring to the vertical shaft drive, it will be noted that helical gears are fitted, and that a special footstep bearing is provided, this being of the Michell type.

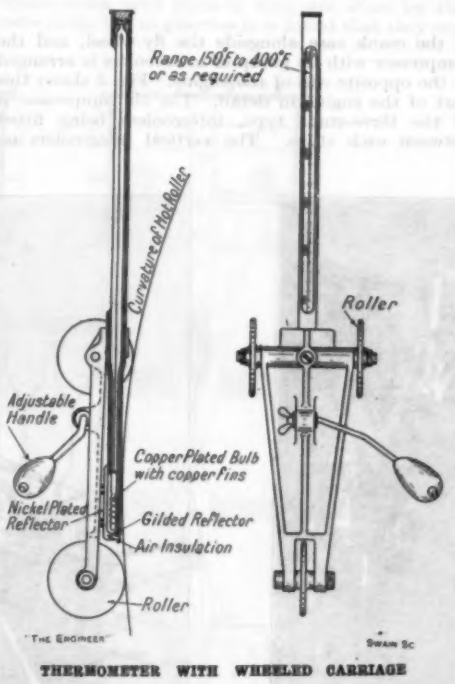
The compressor is driven by an extended crank bolted directly on to the end of the crank shaft, and access to the bottom end is obtained from an inspection door on the end of the bed-plate. The compressor piston is strongly webbed, and is of the built-up type, the high-pressure piston being bolted on to the low-pressure and intermediate-pressure pistons. The compressor valves are of the plate type, and are silent in operation. Similar valves are used on the scavenging pumps.

Although the engine we have described differs in some ways from the marine type of Fullagar engine, all the essential advantages of the Fullagar principle have been retained, and chief among them we may single out the excellent balancing of the reciprocating parts, which not only permits of very even running at a comparatively high speed, but also of a very small cyclic variation with a fly-wheel of moderate size. These are important factors on an engine which has, for instance, to work in electric generating stations. The test figures which have been placed before us show an average fuel consumption of about .42 lb. per brake horse-power at full load, and a slightly smaller consumption when running under overload conditions. These figures compare favourably with the fuel consumption of engines of equal horse-power.

One of the undoubted advantages of the opposed-piston construction and of the Fullagar design, in particular, is the absence of valve gear and cylinder covers, which in the ordinary Diesel engine form a large proportion of the component parts of the engine. If an engine possessing the characteristics we have described can be produced at competitive cost, and we see no reason why it should not, then it will undoubtedly take an important place in the future development of the large-power British oil engine.

Thermometer for Hot Rollers.

A thermometer, illustrated herewith, has recently been produced by Negretti and Zambra, 38, Holborn-viaduct, E.C. 1, for the special purpose of measuring the temperature of the hot rollers or drying drums used in paper-making machines. The thermometer is of the mercury-in-glass type, and is carried inside a steel sheath attached to an aluminium frame fitted with three wheels. The bulb is cylindrical and of very small volume in order to reduce the thermometric lag. It is copper plated, and, in addition, is provided with copper fins with the object



THERMOMETER WITH WHEELED CARRIAGE

of causing it to take up the temperature quickly and sensitively. A small air space surrounds the bulb, the outer boundary of this space being formed by a gilded reflector which reflects on to the bulb the heat given off from the hot roller or drum. Beyond the gilded reflector, with an intervening insulating air space, is a nickel-plated reflector polished on the exterior with the object of preventing heat radiated by outside bodies from reaching the bulb. The bulb does not actually touch the hot roller, for if it did it would receive heat by friction under the rotation of the roller. The three wheels on the frame are so adjusted that the bulb just avoids contact. An adjustable handle is provided on the frame, and may be set angularly so that the thermometer can be held in position without the observer coming into contact with the surrounding parts of the machinery.

That the South-Eastern and Chatham will make a firm stand for exceptionally good terms before joining the Southern Group is shown by what the chairman said at the annual meeting. He considered that his company had a much bigger scope for development than either the Brighton or the South-Western companies. The South-Eastern had its coalfields, and he was glad to say that one of them was doing extraordinarily well. Then it had the continental traffic, the possible Channel Tunnel and the proposed electrification. The electric system proposed was one which would take South-Eastern trains through the Channel Tunnel and on to Paris.

AMERICAN IRON AND STEEL IN 1921.

In the iron and steel industry of the United States the year 1921 was a year of severe depression, according to a review by the *American Iron Age*. It was marked by steadily declining prices, unemployment, successive wage reductions for workmen, and heavy losses for iron and steel companies. Output was on a smaller scale in relation to capacity than in any previous year. Pig iron production was about 16,400,000 tons, or only 44 per cent. of the 1920 production and the lowest recorded since 1908. Steel works produced about 19,250,000 tons of ingots, as against 40,881,000 tons in 1920. In terms of the country's ingot capacity, 1921 will rate as a 38 per cent. year. The decline in prices was from an average of 1.541d. per lb. on January 1st for the seven leading forms of finished steel to 1.031d. per lb. on December 31st. For these seven products, the average above that of 1913 was 85 per cent. at the beginning of the year and only 24 per cent. at the close of the year. Although the depression which began in the last quarter of 1920 was expected to become more acute during 1921, it is thought that the length and depth of the depression—as to both prices and production—was far beyond the most pessimistic prophecy. There are marked indications of a coming improvement, one of these being a check in declining prices and an increase in employment. There is an enormous amount of construction work in all lines which only awaits favourable conditions.

Iron ore shipments on the Great Lakes, from Lake Superior ports, amounted to only 22,300,000 gross tons, the lowest figure since 1904. For the past ten years these water shipments have averaged over 50,000,000 tons annually. On the other hand, as an example of the high development of ore loading and unloading methods, the highest records ever reached were made in 1921. Thus a steamer was loaded with 12,507 gross tons of ore by gravity in 16½ min., and this cargo was unloaded by machinery in 3 h. 5 min.

Three new blast-furnaces were blown in in December, 1920, by the United States Steel Corporation, and another in January, 1921, but in February it blew out fifteen furnaces. The independent steel companies blew out twenty-nine furnaces during the same period. The new open-hearth capacity completed during 1921 amounted to only 247,500 gross tons, this being in eight furnaces of independent companies. For 1922, these companies plan six furnaces, with a total annual capacity of 217,500 tons, but the Steel Corporation plans no new furnaces. Only one new blast-furnace was built in 1921, for an output of 180,000 tons of pig, but this furnace was not blown in. Two furnaces will probably be completed in 1922, for an annual capacity of 310,000 tons. These figures are the lowest for more than twenty-five years. The high record was reached in 1917, when no less than ninety-seven open-hearth furnaces were completed, having an output of 4,336,500 gross tons per year, and fourteen blast-furnaces, having an annual capacity of 4,515,000 gross tons.

INSTITUTE OF TRANSPORT.

A congress of the Institute of Transport will be held in London on May 17th, 18th, 19th, and 20th next. The proceedings will comprise the reading and discussion of papers at meetings to be held on the mornings of the three first days at the Institution of Civil Engineers, Great George-street, Westminster, S.W. A lecture for graduates and students on "The Operation of Heavy Suburban Passenger Services on a Steam Railway, with Particular Reference to Density of Service, Terminal and other Facilities," will be delivered at the Rooms of the Royal Society of Arts, John-street, Adelphi, W.C. 2, at 5 p.m. on the 19th. The afternoons of the three days and the Saturday following will be devoted to visits and inspections. The Lord Mayor of London has invited the delegates to a conversazione at the Mansion House on the evening of May 17th, and the third dinner of the Institute will be held on the following evening. The headquarters of the congress will be at the Hotel Metropole, Northumberland-avenue, W.C. The following programme has been arranged:—On Tuesday, May 16th, the president will hold a reception at the Hotel Metropole from 7 to 10 p.m. On the Wednesday, May 17th, at 9.30 a.m., the president will open the congress, and an official welcome will be extended to English and foreign delegates. The following papers will be taken in the order given:—10 a.m.: "Recent Improvements in Transport Facilities in the Port of London," by Sir Cyril Kirkpatrick; and 11.15 a.m.: "Wireless as an Aid to Transport," by Captain M. H. P. Riall Sankey, C.B., both in the Lecture Theatre of the Institution of Civil Engineers. Also at 10 a.m., "The Design, Construction and Maintenance of Highways in relation to the Development of Mechanically Propelled Vehicular Traffic," by Colonel C. H. Bressey, in the Reading Room. On the Thursday, May 18th, there will be two papers: "Inland Water Transport—a Practical Policy," by Mr. Neville Chamberlain, in the Lecture Theatre; and "The Future Design of Road Vehicles for Passenger and Goods Services," by Sir J. E. Thornycroft, K.B.E., in the Reading Room, both at 10 a.m. On the Friday there will be three papers: "The Finance of the Modern Highway—a Problem and a Solution," by Mr. Dixon H. Davies, in the Lecture Theatre, at 10 a.m.; "Foreign Railway Practice," by Professor J. Carlier, in the Reading Room, at 10 a.m.; and "Safety in Railway Operation," by Colonel J. W. Pringle, C.B., in the Reading Room.

Alternative visits to the following have been arranged:—Wednesday, May 17th, the Royal Victoria, Albert and King George V. Docks; the offices of Marconi's Wireless Telegraph Company, Limited; the new Great West arterial road; the Somers Town goods depôt of the Midland Railway; the Neasden power station of the Metropolitan Railway; the works of Siemens Bros., Limited, at Charlton; the works of the Westinghouse Brake Company at King's Cross. On the Thursday the Chiswick works of the London General Omnibus Company; the power station of the Underground Railways at Lots-road, Chelsea; Waterloo Station; Feltham marshalling yard and Wimbledon power station, London and South-Western Railway; the works of D. Napier and Sons, Limited, at Acton; the works of Straker-Squire, Limited, at Edmonton; the works of the Western Electric Company, Limited, at Woolwich; and the aviation works of Vickers, Limited, at Weybridge. On the Friday, the London Terminal Aerodrome at Croydon; the L.C.C. generating station at Greenwich, and the car repair shed at Charlton; the signal works of the Great Western Railway at Reading. On the Saturday, Liverpool-street Station, to witness early morning suburban traffic operations; the works of Dennis Bros., Limited, at Guildford; Euston Station and Stonebridge Park power station, London and North-Western Railway; and demonstration of pulverised coal and colloidal fuel at Marylebone Station, Great Central Railway.

Railway Matters.

The National Union of Railwaymen has now a membership of 386,115, as compared with 457,882 a year ago and with 481,001 two years ago. The greatest comparative loss is in Ireland.

From what Mr. Neal said in the House of Commons recently, it would appear that complaints as to overcrowding on the underground systems of Paris, Berlin and New York are common.

The amalgamation of the railways in South Wales with the Great Western system will not affect the running powers hitherto possessed by other companies, *e.g.*, the London and North-Western and Midland, over the absorbed lines.

During the year 1921 the South-Eastern and Chatham Railway carried three million more passengers than in 1913, but with a train mileage of 23 per cent. less. The number of passengers in 1921 was, however, 14½ millions less than in 1920.

A junction between the London and North-Western and the Great Western lines at Blaenau-Festiniog having been proposed, the Ministry of Transport laid the matter before the companies, which have now replied that the considerable expenditure cannot be justified.

The Furness Railway Company intends to do everything it can this year to develop passenger traffic by running excursion trains and by making some substantial cuts in the fares charged on the Lakes steamers. As a further instance, the company intends to make a strong effort to recover the excursion traffic from Morecambe, much of which has recently reverted to the roads.

According to figures compiled by the Association of Railway Executives, the revenue of the Class I. railways of the United States for the year 1921 was 10.6 per cent. less than in 1920, but the expenditure was 21.1 per cent. less. The net operating income on the tentative valuation of the companies' property was 3.31 per cent.—a contrast to the 6 per cent. mentioned in the Transportation Act.

The larger number of passengers carried in 1920 as compared with 1919 was said by the chairman of the North Staffordshire Railway to have been due to "an abnormal and unreal possession of wealth which was assumed to be permanent, and which led to extravagances which the country could ill afford. . . . The general reductions in wages and profits had now brought them back to the 1913 circumstances and economies."

The closing of the Solway Junction Railway, owing to the condition of the viaduct over the Solway, was mentioned in this column of our issue of August 5th last. The repairs to the viaduct would be very costly, and the traffic does not justify the expenditure, as it can be sent *viâ* Carlisle. Inquiries made of the Caledonian Railway Company by the Wigton Rural District Council have led to the latter being informed that it is impossible at present to reopen the railway.

The question was recently asked whether any preliminary surveys had been made for the electrification of railways in the coalfields of South Yorkshire, Nottinghamshire and Derbyshire, and whether any railway route in these areas was to be electrified. Mr. Neal, in reply, said he had made inquiries, and had been informed that the railway companies concerned are not at present considering any project for the electrification of any of their lines in the area referred to.

The Parliamentary Secretary to the Ministry of Transport recently had to justify the expense incurred by railway companies in the preparation of the statistics required under the Railways Act. Mr. Neal said that the figures constitute a general guide to the efficiency of the operation of the railways, and as such they are of service to the railway managements which are bound to maintain statistics of this or a similar nature for their own purposes. They were also essential to the work of the Rates Tribunal.

It was in 1913 that the Great Western Railway Company introduced its "Safety" movement, and the following figures, taken from the *Great Western Railway Magazine*, show that the cultivation of greater care and forethought advocated by that movement has been productive of good. These are the numbers of personal injuries in "movement" accidents for the last nine years:—1913, 3375; 1914, 3259; 1915, 2728; 1916, 2422; 1917, 2445; 1918, 2167; 1919, 2153; 1920, 2287; 1921, 1647.

Route indicating signals have only one arm, the lowering of which exposes a lettered or numbered sign indicating the direction the road is "made" for. These signals have one disadvantage. They do not tell platelayers and others working behind the signal on which line an approaching train will travel and whether, therefore, they are in danger. At St. Pancras, where the arrival signals have route indicators, the Midland Company has provided a "platelayer's warning signal" on the signal-box which faces the station and repeats the sign given by the route indicator.

In the course of a lecture before the Department of Commerce, University of Liverpool, Mr. S. B. Canter, the Liverpool district passenger superintendent of the London and North-Western Railway, said that few travellers have any conception of the way our systems are all interwoven as regards connecting trains, and he gave the following illustration:—A good many years ago, before Crewe Station was enlarged, the late running of the 11 a.m. Paddington to Penzance on a Monday would cause a late arrival into Euston on Wednesday morning of the 9 p.m. from Perth. The late running of the train from Paddington over the single line beyond Dawlish upset the working of the 3 p.m. from Penzance, which made the 7.40 from Bristol to Crewe on Monday night late from Bristol. This blocked that train out of Crewe and caused the down postal express to wait for the mails at Crewe. This in turn caused a late start to the 5.30 from Perth to Inverness on Tuesday morning. The late running of the Inverness train upset the single-line working on the Highland Railway north of Inverness, and in consequence the 3.50 from Inverness on Tuesday afternoon reached Perth late, and detained the 9 p.m. Perth to London, which reached Euston late on Wednesday morning.

Notes and Memoranda.

An illustration is given in the *Edgar Allen News* of a large circular saw for cutting stone. It is 100½in. in diameter, about ½in. thick, and weighs about 8 cwt. Round its periphery are some 210 diamonds, and when put to work it will travel at a peripheral speed of about 3 miles per minute, and will cut through a stone slab 6ft. by 3ft. in fifteen minutes, as compared with six hours taken by the old horizontal machine.

The British South Africa Company announces the following mineral output from Southern Rhodesia for February:—Gold, 51,422 oz. (as compared with 53,541 oz. in January); silver, 14,404 oz. (against 13,696 oz.); coal, 36,521 tons (against 49,830 tons); chrome ore, nil (against 1464 tons); copper, 284 tons (against 286 tons); asbestos, 380 tons (against 558 tons); arsenic, 46 tons (against 41 tons); and mica, 1 ton (against 4 tons).

The largest iron mine in the Shantung province of China is that at Ching Ling Chen, in Itu. There are magnetite, limonite, and hematite in this mine, and the Germans formerly had ambitious plans with respect to it. It now belongs to the Shantung Railway and is owned entirely by Japanese. It is reported that the quantity of iron in this mine is 14,000,000 tons. The coal mines at Hangsan and Ninyang have a combined yearly output of 900,000 tons.

It was proposed by Mr. L. D. Hingle, in the course of a paper read before the South African Institution of Engineers, that timber might be preserved by soaking it in the waste zinc sulphate solutions of the gold mines. He had experimented with mine timbers, both soaked in open tanks and in old boiler shells fitted with steam coils. The treated timber was in good condition after service for two and a-half years underground, while untreated props had almost rotted away entirely.

A description is given in the *Engineering News Record* of the cutting of a 36in. cast iron water main, at the bottom of a river 50ft. deep, by means of an "electric torch." A section of the pipe was removed in nine working days. The current required was 350 ampères at from 60 to 100 volts. The torch consists of a carbon electrode which is bored for the passage of cutting gas, the carbon being connected to one pole of a generator, the other pole being grounded through the water to the metal to be cut. A carbon will last about twenty minutes, and while a diver may cut an inch in ten minutes, an average of 2in. per hour is considered very good progress with cast iron 1¼in. thick.

The total amount of sulphur in coal may be rapidly determined, according to the *Iron and Coal Trades Review*, in the following manner:—One gramme of the coal is intimately mixed in a porcelain crucible with two grammes copper oxide and one gramme anhydrous sodium carbonate. The crucible is placed on an asbestos ring and heated with a Bunsen burner; if stirred occasionally, the action is complete in about two hours. When cold, the crucible is transferred to a large beaker and moistened with bromine water to oxidise any sulphides to sulphates; the residue is then treated with hydrochloric acid and bromine water, heated to effect solution, and finally to exclude bromine, filtered, and the sulphur estimated in the filtrate in the usual way.

A paper on "The Influence of Structure on the Combustibility and other Properties of Solid Fuels," by Messrs. E. R. Sutcliffe and Edgar C. Evans, was read recently by Mr. Evans at a meeting of the London Section of the Society of Chemical Industry. The paper dealt, in the first place, with the work which has been carried out by various investigators on the subject of structure in relation to combustibility of fuels, but it was pointed out that nobody had gone into the subject in very great detail. The combustibility of coal was not altogether a question of its heat value, but one in which the structure of the residue after the gases had been driven out played an important part. Homogeneity of a fuel was an important factor, and a far greater consumption of fuel per square foot of grate area was obtained by ensuring as far as possible uniformity of size of the particles, except, of course, in the case of caking coals.

In the course of a paper on "Petroleum and Lubrication," read before the Institute of Marine Engineers, Mr. E. A. Evans said that in oils as supplied to the user the possibilities of the presence of inorganic suspensions are remote, but the presence of organic colloids is almost assured, and it is chiefly to them that emulsification is attributable. In order to obtain a non-emulsifiable oil the colloids have to be removed or rendered innocuous. The colloids may be present as soaps, asphaltic substances, or even certain varieties of paraffin wax. That other emulsifying agents may be also present is not denied, but further evidence of their presence and influence is wanted. Non-emulsifiable oils, when stored in wooden barrels, which have been treated with glue, and left exposed to the weather, are liable to revert into emulsifiable oils, on account of the rain softening the glue and becoming dispersed in the oil. The trouble is aggravated if the oil should be acid or alkaline, as acid and alkali-albumins are very effective emulsifying agents.

In commenting on the explosion of a flexible bronze steam pipe, 6in. in diameter, intended for working at a pressure of 180 lb. per square inch in a Belfast factory, the Engineer Surveyor-in-Chief to the Board of Trade remarks that it failed whilst it was being used for the first time under a steam pressure much lower than that for which its makers apparently considered it to be suitable. The firm using it obtained the pipe for use in testing new machinery under steam in their works, and a flexible pipe was chosen so that it might accommodate itself to any irregularity of position with respect to or of distance from the permanent steam pipe line. Such a pipe should manifestly be capable of resisting any ordinary deformation, and as there is no evidence of the pipe having been subjected to improper treatment before its use on the occasion of its failure, the conclusion that must be inevitably come to is that the pipe was unfit for the pressure for which it was intended. Neither the owner nor the maker appears to have appreciated the risk run in using, under such circumstances, a pipe which the latter deemed it inadvisable to subject to a pressure test of more than the maximum steam pressure it was intended to work under.

Miscellanea.

It is understood that the Government of the United Provinces is considering the question of erecting a large modern institution for the training of mechanical and electrical engineers. The college will be situated at Lucknow.

We are informed that the Institution of British Foundrymen, which has recently secured its Royal Charter, will hold a conference in Birmingham, the city of its origin, from June 20th to 23rd inclusive. A foundry trades exhibition will be held in conjunction with the conference, and will remain open for ten days.

A Bill, providing for increased import duties on copper, brass, and bronze, has passed the Japanese Diet and became effective as from March 30th. Details of the Bill have not yet been received by the Board of Trade, but it is understood that the former duty of 1.30 yen per 100 kin on copper ingots will be increased to 7 yen, and that waste brass and bronze, formerly duty-free, will be subject to duty at the same rate.

The Air Ministry has just announced that the prizes in the Air Ministry competition for safety fuel tanks for aircraft have been awarded as follows:—First prize (£1400), the India-Rubber, Gutta Percha, and Telegraph Works Company, Limited, Silvertown, London, E. 16; second prize (£400), Imber Anti-fire Tanks, Limited, West-road, Tottenham, London, N. 17; and third prize (£200), Commander F. L. M. Boothby (R.N. retired), Overway, Tilford, Surrey.

It has been announced that the American national balloon race this year will start from Milwaukee, Wis., on May 31st, under the auspices of the Aero Club of Wisconsin. The first three finishers of the race will probably be selected to represent the United States in the International Gordon Bennett Cup Race, which is to be held at Geneva on August 6th. The United States Army and Navy have each signified their intention of entering three balloons in the American race, and prizes ranging from 1000 dollars for the winner to 100 dollars for sixth place will be awarded.

An exhibition of contemporary British architecture will be held in the Galleries of the Royal Institute of British Architects, 9, Conduit-street, W. 1, from November 1st to December 16th, 1922. Among the regulations made in connection with it are that all architects in the British Empire are invited to submit their work; that work that has already been exhibited elsewhere will not be excluded; and that exhibits must be confined to works executed or illustrations of works projected since the beginning of the twentieth century. The last day for the receipt of drawings and photographs will be October 7th next.

It is stated that in the event of the success of an experiment now being conducted in New Zealand by the Union Steamship Company, in converting a former hulk into a modern coal-handling machine at a cost of £100,000, including £25,000 for the steel superstructure which has been erected, the work of similarly converting the barque Shandon, at present lying at Melbourne, will be commenced. The converted hulk in New Zealand is capable of bunkering steamers at the rate of 120 tons per hour. A steel skeleton tower, 92ft. in height, has been constructed above the deck, and from it there extends over each side of the vessel a steel arm about 60ft. long.

It is announced that the large new liner Giulio Cesare, 22,000 tons, of the N.G.I. (Navigazione Generale Italiana) will sail on her maiden voyage from Genoa to Rio di Janeiro and Buenos Aires, *viâ* Barcelona, on May 4th. This fine vessel, with her sister-ship the Duilio, which is nearing completion, will perform the voyage from Genoa to Rio in 10 days, and to Buenos Aires in 13½ days, the time from Barcelona being one day less in each case. These times, together with the two days between the departure from London on the overland journey and the sailing of the vessel from Barcelona will, it is said, reduce the actual time to a minimum of 11 days from London to Rio and to 14½ days from London to Buenos Aires. Special arrangements have, we understand, been made for the convenience of travellers from England in connection with the journey across France to Genoa and to Barcelona.

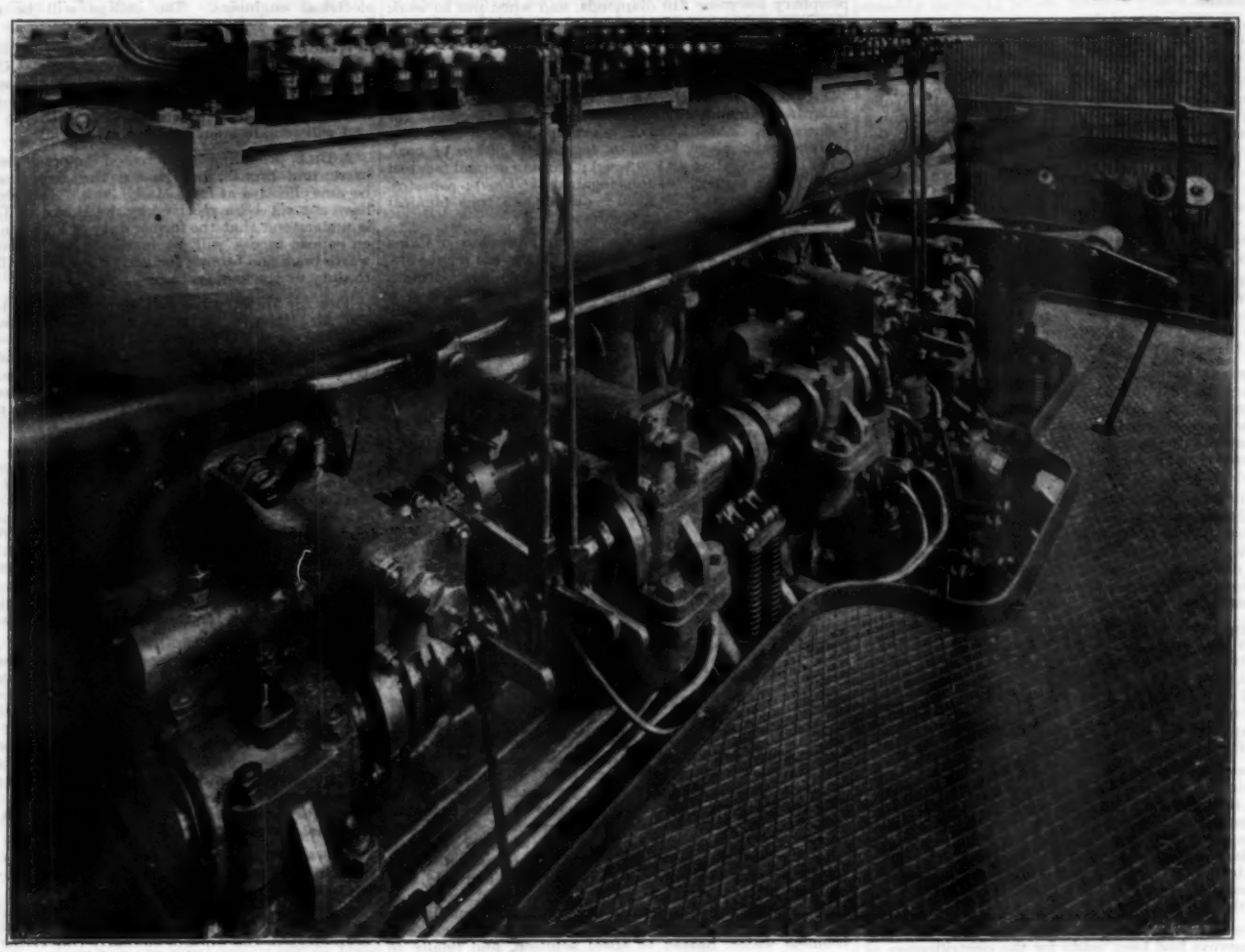
In a recent address to the Newcastle and Gateshead Chamber of Commerce, Sir William Noble, Engineer-in-Chief to the General Post Office, said it had been decided to change the existing telephone plant in Newcastle by substituting automatic equipment. The first exchanges to be dealt with would be the Central and City, Newcastle and Gateshead. The territory at present served by the Central and City would be in future divided between one large automatic exchange to be called the Central, and two smaller ones, named East and West. Plans were in hand for three new exchange buildings on the north side of the Tyne, and the building at Gateshead was in course of erection. Immediately the buildings were ready, installation work would be commenced. The reconstruction of plant at the remaining exchanges within the five-mile radius would be undertaken from time to time as might be necessary.

Owing to the internal industrial situation, it is interesting to see how Germany's power requirements are being increasingly met by the use of water and lignite. In 1913, states the *Electrician*, about 75 per cent. of the whole of the electricity supply was produced by ordinary coal, water power and brown coal (lignite) accounting for about 15 per cent. of the balance. It is now stated that only about 15 per cent. of black coal is used, the proportion of lignite having increased to nearly 35 per cent. The annual production of lignite in Germany was 111,635,000 tons in 1920, that of black coal being 131,428,000 tons. In eight or ten years it is calculated that, by an extension of existing hydro-electric stations, together with new water-power projects, it will be possible to generate 50 per cent. of the whole of the power required for industrial and private uses and for traction by means of water power alone. In Bavaria and the South German States hydro-electric developments will enable the use of ordinary coal for industrial work to be almost entirely dispensed with, and make possible the electrification of the whole of the railways of South Germany.

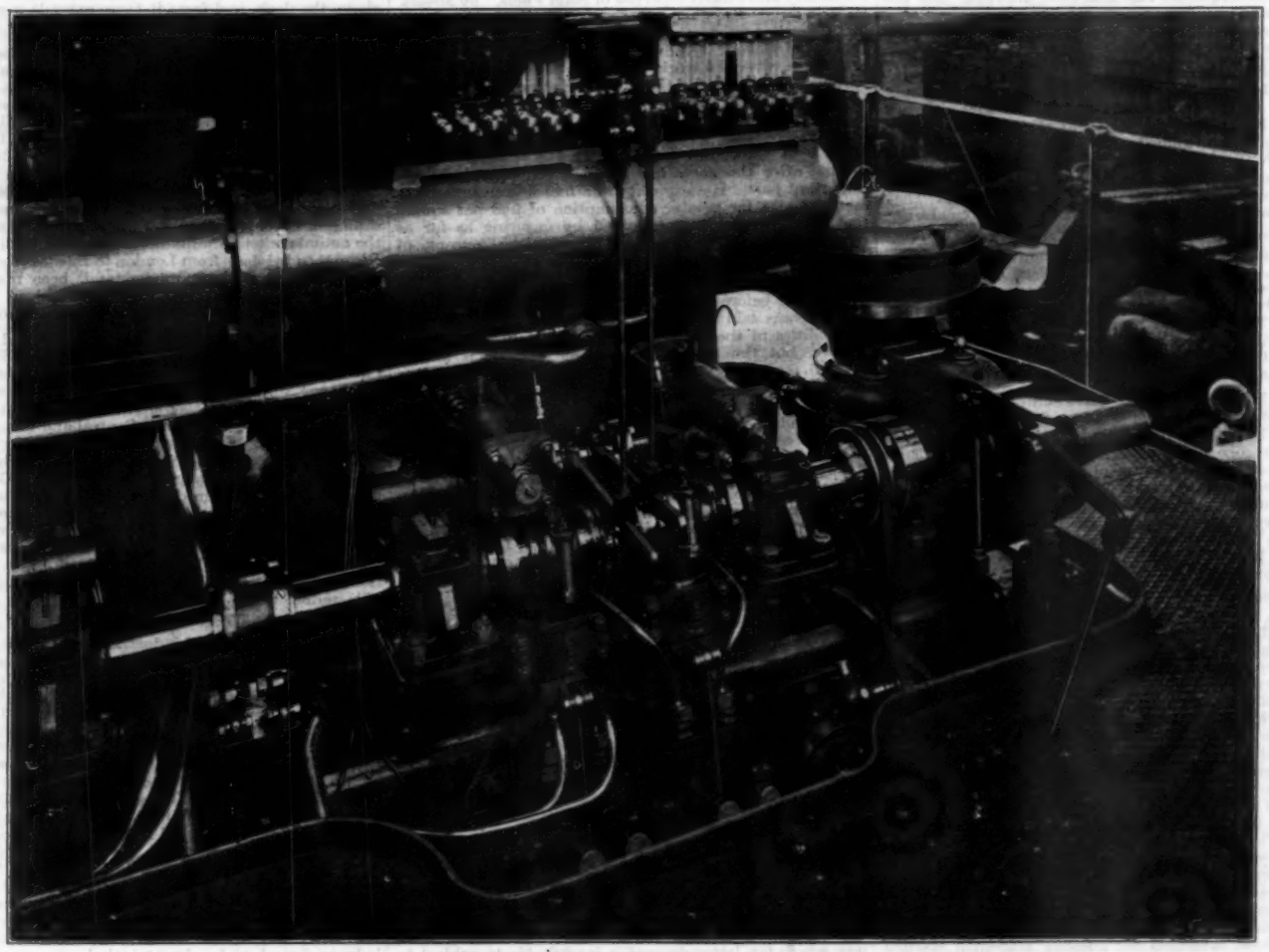
750 BRAKE HORSE-POWER FULLAGAR OIL ENGINE

THE ENGLISH ELECTRIC COMPANY, LIMITED, WILLANS' WORKS, RUGBY, ENGINEERS

(*For description see page 466*)



CAM SHAFT AND FUEL VALVE GEAR



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THE ENGINEER.

APRIL 28, 1922.

Managerial Functions.

The efforts to maintain peace in the engineering trades have come to nought. On Monday last negotiations broke down, on the following day lock-out notices were posted in all Federated shops, and on Tuesday next several hundreds of thousand more men will be thrown out of employment. Yesterday the Parliamentary Labour Party, at the request of the National Joint Council and the Amalgamated Engineering Union, invited Parliament to appoint an Industrial Court to investigate the matter in dispute, and on Monday the Employers' Federations informed the unions that in the event of such a Court being instituted, they would feel themselves no longer bound "by the terms of any proposals which have been made by them or on their behalf since the commencement of negotiations." The employers are still ready to resume discussion on the basis of their memorandum of Saturday last, but in view of the sequence of events outlined above and of the rejection of the memorandum referred to, the breakdown of the negotiations must be regarded as complete. The position is almost precisely what it was when two months ago the Federated shops were closed to members of the Amalgamated Engineering Union; the employers are still insisting on the right to exercise "managerial functions" and the unions are still endeavouring to diminish those rights almost to the vanishing point.

There comes a time in all unsuccessful negotiations when further discussion is fruitless, and no alternative remains but a trial of strength for mastership. Recognising fully the seriousness of our words, we feel constrained to say that in our own opinion that time has now arrived in the engineering industry. For years past negotiations and discussions have followed fast upon each other's heels, and have been succeeded by compromise upon compromise. But they have brought us no nearer industrial peace, and the question forces itself upon us whether it would not be better once for all to determine who is to be master than to continue these unending repetitions of a struggle which always ends indecisively, and hence leaves always encouragement to those who desire to renew it. We have no desire at all to see trade unionism destroyed, but we are far from certain that it would not be well for the country as a whole that the trade unions as they now exist should be removed, and that their place should be taken by new societies inspired by a different spirit. The evidence is too strong to admit of any doubt that the unions as they now exist are in a large measure political bodies, and that they exercise the peculiar powers which misguided Parliaments have conferred upon them to further their own political ends. It is so plainly undesirable that the industries of the country should be made the shuttlecock of political partisans that the necessity of reducing as far as humanly possible that element in trade unionism must be manifest to all save those who desire to use it for their own purposes. But whilst the political factor in modern trades unionism is one of those things that it is desirable to remove, it is, perhaps, neither the greatest nor the most sinister. It will always be countered to a material degree by the political differences of opinion which exist between man and man, even in the shop, and whilst it may from time to time lead to serious outbreaks, it is doubtful if in the end it can do so much harm to industry as the restrictions imposed or inspired by trades unionism on the development of factory efficiency. It is usual to estimate the damage effected by strikes as so many millions of working hours lost. There are fifteen million "workers" in this country. They do in all about three thousand million hours of work per month. If half a million go out on strike, they lose in all about one hundred million working hours per month, or, in round numbers, taken over the whole working population, about six and a-half hours per month per person. The reduction of the working day from nine hours to eight means roughly the loss of twenty-four hours a month, and the effect of the various systems of restricting output, if we put it as low as twelve per cent., means the loss of as much again. It must, moreover, be remembered that the loss owing to short hours and restricted output is continuous, so that the total number of hours lost per year from those two causes amounts to over five hundred and seventy per person, as against the six and a-half lost in a one-month's strike. We do not present these figures with any intention of depreciating the harm done by a strike or lock-out, which extends, as a matter of fact, far beyond the mere loss of hours, but to make clear, in the terms of a factor that is commonly used, the waste of the industrial power of the country which was brought about by the wholesale shortening of working hours combined with resistance to the adoption of means for accelerating output and the extension of the "ca' canny" principle. The comparison we have made shows that, bad as a strike or lock-out may be, it is far less injurious, measured in hours lost, than shortening the working day and reducing output per man. It shows also that the employers on economic grounds are justified in locking out if thereby they can secure conditions which will enable them to increase, though it be but in a small measure, the productive efficiency of their factories.

It is always said by the advocates of peace at any price that a fight to the end must leave soreness of spirit behind it, and engender hatred and revenge. That statement may be accepted as a truth; but we would point out, in the first place, that class hatred is already encouraged by the men who are foremost in fomenting these troubles, and that we shall be no worse off for having them as avowed enemies, and, in the second place, we assert that in the unions there are large numbers of men who would only be too glad to see the turbulent element overthrown—men who would like to be left to live their lives peacefully and industriously; men who are glad to leave to the employers the responsibilities that are rightly theirs; men who would gladly work to their highest efficiency, and who would take pride in their work and in their firms. We invite the unions in the present dispute to put the matter to the test. Let them, rather than invoking the doubtful aid of an Industrial Court, ask Parliament to arrange for a secret ballot of all workers engaged in the engineering and allied trades on this single issue of managerial functions. The issue at stake in this dispute is far greater than appears on the surface. It cannot be settled, as some seem to imagine, by the discovery of a formula. It is no less than the right of the employer to increase the labour efficiency of his factory. For that he must contend if the engineering industries of Great Britain are to hold their position against world competition.

Turbine Reduction Gearing.

The trouble experienced with the installations of double reduction gearing, both in America and in this country, has enforced a closer and more thorough investigation of the problems involved. For obvious reasons, very little information was available until the end of the war; but since that time there has been a steady accession of new facts concerning reduction gearing and its performance. Among the more important contributions to this

important subject are the papers which from time to time have been read before the Institution of Naval Architects, and those presented at the recent meetings proved to be no exception, either in regard to their informative interest or the value of the discussion which they elicited. Dr. Smith and Mr. A. Wilkie dealt respectively with the mathematical and practical aspects of the trouble which was given by the gears first installed in the ss. Melmore Head, and they described the steps which were taken to overcome this trouble. The authors are to be complimented on having surmounted the difficulties with which they were confronted, and also on the very clear way in which they have placed on record their findings and the remedy which they worked out and adopted. A similar frank and candid account of gear trouble when it is met with would, in our opinion, do much to enable the remaining uncertainties and difficulties to be overcome. While we cannot fully agree with the authors that the Nodal drive is a cure for all gearing troubles, considerable interest attaches to the results already obtained, and we hope similar reports will be forthcoming from the three ships fitted with that drive which are now in commission.

A large amount of information is now available as to the running and performance of known installations, and the number of failures is surprisingly small. A recent authority stated that, out of thirty-five ships fitted with single reduction gears only two had given trouble, and out of one hundred and thirty ships fitted with double reduction gearing, there had been eight cases of broken teeth, in five of which the first reduction pinion was concerned and in three the second reduction pinion. In the 130 ships there were in all 600 gear wheels. In view of such facts we may say safely that the experimental stage of reduction gearing is now passed, and that we have reached a point where it is possible to evaluate more correctly the experience which has been obtained. The consensus of opinion of designers, builders and users would seem to point with increasing conviction to one important essential—accuracy—in all stages of construction combined with the use of the best materials. One of the most important of the recent advances in the science of gear cutting is the perfecting of methods and instruments whereby the tooth thickness and pitch of wheels may be accurately measured and compared. The application of such methods of testing, not only to gears in process of completion in the workshop, but also to the periodical examination of gears in service, would appear to yield valuable data as to possible errors and their magnitude. Where such investigations have been made, considerable and often unexpected errors have been shown to exist in both pinions and wheels, and it has been established that such errors are inseparably connected with noise and vibration. Whichever system of tooth generation is adopted, and there are equally strong advocates of the generating, milling and hobbing methods, it will be readily conceded that primary accuracy in dividing wheels and leading screws is a matter of fundamental importance, for without it no really satisfactory work can be expected. Much has been achieved towards this desirable end, but it does not yet appear to us that the limit of accuracy in workshop practice or construction has been reached, and further attention cannot fail to bring about more perfect results. The introduction of the creep arrangement by Sir Charles Parsons was certainly the means of providing a method whereby any inherent inaccuracy in the master wheel was distributed around the wheel cut, and the thinner tooth and increased tooth space resulting from this method of cutting would seem to have improved the quietness of running by permitting the formation of a more dense film of lubricant. Recently, however, there has arisen a tendency on the part of some gear makers to abandon creep cutting, in view of the reason that any wear on the gears which operate the creep motion introduces errors of uncertain value, and it is stated that such errors are in magnitude larger than those contained in the master wheel. This is a point which would bear further investigation. Another important factor in producing accurate results is the proper appreciation of those forces in operation during cutting which are liable to introduce varying factors. The wear on hobs and tools must be carefully considered, and the stability and rigidity of the gear-cutting machine itself must be assured, especially in the case of wheels of large diameter. Turning to the design of the gear case and its attachments, we find need for greater simplification in the lubricating and cooling systems adopted, and gear case fittings might be designed to resist the stresses due to vibration and to meet the uncertain forces which are introduced by the rolling, pitching and wringing of ships. The question of providing sufficient elasticity between the pinion and the mass to which it is attached is receiving attention, and beneficial results, as already noticed, are claimed. Considerable work has been done and is still in progress on the examination and testing of gear teeth broken in use, and the results obtained would seem to indicate that while, generally speaking, the material itself may not be the direct cause of failure, yet there is, nevertheless, room for further investigation of the relative merits of the various alloy steels, particularly for the making of pinions. The requirements with regard to hardness, toughness and freedom from brittleness are well known, but comparative information as to the behaviour of various steels under known conditions of gear loading would be of great value at the present juncture. In some cases failure has been attributed to the existence of fine hair cracks in the original forging, and wheel blanks have been known to have been condemned for this reason before cutting. Hence the question of forging and heat treatment in relation to the shape of gear blanks is of considerable importance.

We have briefly touched upon some of the main lines of development which are now occupying the attention of steel makers, gear cutters and marine engineers, and, in our opinion, there is every reason to expect that efficient co-operation will bring about more silent and reliable gears, and the occasional trouble which is now from time to time met with will be eliminated. Yet when all the troubles have been removed, the gear will remain an interloper between the engine and its work. The fact is, that the turbine and the propeller do not suit each other. The gear is now a very large and very expensive item. It gives anxiety and will always demand constant attention. Inventors may profitably busy themselves in searching for means of removing it altogether by the discovery of means of preventing cavitation or, alternatively, of finding some form of speed-reducing apparatus less subject to objection than toothed wheels.

The International Railway Congress.

No. I.

The ninth congress of the International Railway Association was opened in Rome on the afternoon of Tuesday, the 18th instant. The chair was taken by Mr. Riccio, Minister of Public Works, and the ceremony was honoured by the presence of H.M. the King of Italy. In welcoming the delegates, the chairman quoted from an address given at the opening of the Milan congress of 1887, wherein the then Minister of Public Works said that Italy had not been able to take her place in the nations of Europe because she was suffering from the consequences of the system of Metternich and of the Holy Alliance, who specially suspected and feared railways, considering them, not without reason, as revolutionary elements. The debt had now, said Mr. Riccio, been paid. Notwithstanding inevitable errors, technical and financial difficulties, Italy has carried out the solemn engagement made by her Minister (in 1887). In 1886 there were 6720 miles of railway and 280 miles of secondary line; now there are 11,000 miles of main railway and 2000 miles of secondary line. There are under construction for the State Railways 437 miles of ordinary line and 118 miles of narrow gauge, besides 680 miles for private railway companies, and schemes for new railways for the State amounting to 205 miles of ordinary railway and 500 miles of narrow gauge, and for the private companies to 137 miles of railway were under consideration.

Mr. V. Tondelier, of the Belgian State Railways, president of the Association, in replying, drew attention to the fact that, as at Milan in 1887, the definite statutes of the congress were drawn up, so "on the hospitable soil of Italy" the revised statutes necessary as a consequence of the reconstruction of the Association would be voted. The chair was then taken by Mr. C. Crova, the Director-General of the Italian State Railways, who said that since the State assumed, in 1905, the control of all the railways in Italy, there had been an addition of 315 miles. The administration was proceeding with the greatest possible activity, compatible with after-war difficulties, with another 550 miles, of which 437 miles were ordinary railways. Among the latter were the Florence-Bologna and Genoa-Arquata lines, both of which pierce the Appenines, the first with a tunnel of 11½ miles, the second with one of nearly 10 miles. There was also the Rome-Naples direct line, which included many engineering works and several tunnels, two of which were from 4 to 5 miles long. Italy possessed ninety-five locomotive depôts, the machinery for which had cost over sixteen million lire; ten locomotive workshops, with two more in prospect; and twenty-eight water softening and purifying plants. On the subject of electrification, Mr. Crova said that in six or seven years' time it would, he hoped, be possible to work by electricity 3125 miles of railway for heavy traffic. The lines Bologna-Florence, Faenza-Bologna, Genoa-Pisa, Rome-Tivoli, Rome-Anzio-Nettuno, were being electrified, and by the completion of the Ronco-Profarello section the whole line between Genoa and Modane was electrically operated.

At a meeting, earlier in the day, of the Permanent Commission, Mr. J. Verdeyen, of the Belgian State Railways, who had acted as assistant to the late M. Weissenbruch, the secretary-general, was made one of three secretaries-general; the other two are Sir Henry Fowler, of the Midland Railway, and Mr. Enrico Franza, of the Italian State Railways. Sir Henry has, we believe, been responsible for some months past for the English edition of the Bulletin of the Association.

The general business of the congress began on Wednesday, the 19th. On this point it should be noted that whilst the Permanent Commission courteously sent to us and to other papers an invitation to Rome for the congress, the cards conveyed the intimation that, whilst authorising the holder to be present at the opening and concluding ceremonies, they did not include access to the sessions. Our representative pointed out to two English members of the Permanent Commission that this embargo militated against the good work of the congress being more widely known, and they were kind enough to mention the matter when that body met on Tuesday morning, the 18th. It was decided, however, that there should be no departure from the rule; moreover, the chairmen of the various sections were instructed to announce at their meetings that no information was to be given out by members; that any notes used by delegates in their remarks were to be handed to the secretary of the section; and that every communication for the Press must go through the secretary and be published in the Daily Bulletin. The reason for this step is, we understand, to prevent any incorrect account of the discussions from appearing. A better course, we suggest, would be to invite only responsible journals, the representatives of which know what is being talked about, to attend.

As a matter of fact, representatives of the Press find no difficulty in getting into the sessions, but they necessarily cannot sit in a position to hear what is said. Added to this drawback is the greater difficulty caused by the bad acoustics of the rooms; of delegates chattering together in English, French, Italian, and Spanish; and lastly, that only curtains separate the meetings from the public rooms.

As showing the inconvenience caused by the only source of information being the Daily Bulletin, it may be said that at the time of writing three Bulletins had been issued, but no account had then appeared of any business done since the opening ceremony on Tuesday, the 18th. The reports on electric traction make Section II. the most popular. That subject was discussed on Wednesday afternoon, Thursday, and Friday afternoons and ajourned until Monday, the 24th.

Literature.

British Railways and the Great War; Organisation, Efforts, Difficulties and Achievements. By Edwin A. Pratt. London: Selwyn and Blount, Limited, 21, York-buildings, Adelphi, W.C. 2. 1921. Two volumes. £2 2s. net.

Approaching these volumes with some little acquaintance with the inner working of the railways during the war period, and knowing as we do how effectively the railways did their work, we find, with some surprise, that Mr. Pratt has been very sparing in praise of them. But our surprise is modified when we turn to the preface, where the author tells us he "has refrained from attempting to enter upon any eulogy of his own concerning the achievements of the Railway Executive Committee, the railway companies and the railway staffs of all grades under the conditions detailed." He has thought it more fitting to give, in an appendix, a collection of "Public Tributes to Railway Efficiency during the State Control Period." In the selections thus given the author has had a happy success, as the testimonies are from the highest possible authorities and praise the railways in generous, sincere tones.

Mr. Pratt has written very fully of the many events of the war with which our railways were associated that are little known, and throughout both volumes one is constantly running against some incident which excites interest. One thing he has omitted to tell us, but he is not alone in that omission, as all other writers have failed to mention it. Perhaps this silence may hitherto have been wise, but in view of the happier situation in Ireland, we think the fact should be known. The mobilisation scheme put into operation when war was declared was altered in one very vital matter almost as soon as it began. The scheme provided that the trains and steamers conveying troops from Ireland should carry Territorials to Ireland to take the place of the regular troops. As the Irish people were, however, with us when we set out in defence of Belgium, there was

no occasion to leave regular troops in Ireland, and the return trains and steamers ran empty.

In a work of such a character as this, consisting as it does of seventy-four chapters and nearly 1200 pages, it is difficult to single out any portions for specific mention, especially when almost every page is of interest to some readers, if not to all. We can, therefore, only make some selections at random on various phases of the subject under review. It is not surprising to hear of the reluctance shown by naval and military authorities to entrust civilians, even of the standing and responsibility of railway managers, with the secret of their mobilisation plans. In 1905 it was proposed to have a special railway reserve. The men were to remain with the railways, and should occasion arise they would be available "to take over the working of any railways captured or newly constructed." The offer made by the War Office to the men was considered by the companies to be inadequate. Another proposal of that time was that the railways should provide 100 locomotives and 3300 carriages and wagons. The companies asked for a certain registration fee per annum, but the War Office refused on the ground that certain colonial companies made such provision gratuitously. On the railways pointing out that they were commercial undertakings and not State-owned, the subject dropped. Mr. Pratt devotes a chapter to the question of whether the railways should not have been controlled under the National Defence Act of 1888 instead of under that of 1871. It is news to us, but we are not surprised to hear it, that the Act of 1871 seems to have been passed without the knowledge of certain authorities in the War Office, who, immediately they saw it in print, "regarded with great disapproval the prospect which seemed to them to be opened out alike to that Department, to the the Government, and to the country, by the clause here in question." They expected that the Government would "seek to manage and work the lines with the help of a staff improvised for the occasion." These views were submitted to Mr. Cardwell, the author of the Act, and he is said to have "admitted" that the power taken under the Act was in excess of requirements, and "would never be used." The clause was to be treated as a dead letter and lesser powers were to be acquired at the first opportunity. After the Act of 1888 was passed the expectation was general that the later Act would supersede the earlier, but it seems that in 1911 it was considered by the then managers that the Act of 1871 was more general in its application than that of 1888, and it was recommended that, in the event of control being necessary, it should be granted under the earlier powers. We do not consider this decision was a wise one. All that the Government wanted was precedence for its traffic. That could have been obtained under the Act of 1888; moreover—and this is a significant fact—there would have been no need for the railways to be controlled. What we have always imagined to have been the factor that secured the favour of the companies toward the Act of 1871 was that it gave them "full compensation," whereas the Act of 1888 promised only "such reasonable compensation as may seem just."

Some details are given of the labours of the members of the Railway Executive Committee. Until August 24th, 1914, they met daily at 10 a.m., 2 p.m., 6 p.m., and 9.15 p.m., and for a long time afterwards twice a day. Each member, before leaving No. 35, Parliament-street, left a memo. as to where he could be found at any moment up to the time for the next meeting. During its nearly 5½ years' existence it passed 5515 minutes, which, on type-written sheets of foolscap, fill thirty-four bulky volumes, and issued 2047 instructions, copies of which fill thirty-one volumes. Up to the spring of 1917 the staff consisted of a secretary, assistant secretary, six men clerks, six women clerks and three messengers. By the autumn of 1919 this staff had been increased to thirteen men clerks, fourteen women clerks, and four messengers. Mr. Pratt very fairly explains that the companies had their own staffs to fall back upon, and so there was no necessity for a large number at Westminster. Moreover, the Railway Executive controlled the railways, but it was not responsible for their operation.

Particulars are found here and there of the way in which the railways were handicapped by various departments of the Government. There was, for instance, the question of the munitions workers' privileges. Before we deal with this point it is advisable that we should remind our readers that it was at the beginning of 1917 that the increase of 50 per cent. was made in fares and other obstacles placed in the way of passenger travel. Early that year it was thought desirable that married munitions workers, said to number 80,000, should have week-end tickets, once a month, to visit their homes. Down to June, instead of 20,000 a week expected, there were only 5000 or 6000, so 1000 passes a week were placed at the disposal of the Admiralty and 500 at that of the War Office. Rather than confess that it had asked for too much, the Ministry of Munitions proceeded to distribute tickets with a generous hand among the unmarried also. At the August, 1917, Bank Holiday it asked for—and got—an additional 40,000, and at Christmas 60,000. At Easter, 1918, despite the appeals to workers not to take holidays, because of the serious condition on the Western Front, it had 80,000, and another 80,000 at Whitsuntide.

Another way in which the railway companies were embarrassed was by the unreasonable demands of Government departments on the wagon supply. Considering how traders were handicapped and the country suffered in its food and coal supply owing to the scarcity of wagons, it is a pity that some of the details Mr. Pratt now gives were not made public at the time. Fortunately, the authorities saw the error of their ways and amended them in time.

Of the many attractive chapters in this work, the one that perhaps appealed to us the most is XXX., "Railways and Air Raids." The railway companies, in particular the Great Eastern, were able to render the War Office considerable assistance in the way of warnings as to the movements of enemy aircraft. In the national interests it was desirable that the railways should continue at work until the last available moment, and with that purpose in view the country was divided into forty-four districts. Four messages were adopted:—(1) Warning only, District No. ——; (2) Take air raid action, District No. ——; (3) Resume normal conditions, District No. ——; (4) All clear. These arrangements had the effect of keeping all the lines in work except in the threatened areas, and in the latter work was not actually stopped until danger was near. Later, instead of the above messages, the four colours green, red, yellow, and white were adopted. Some excellent reproductions of charts taken by the Great Eastern appear in this chapter. From a table given on page 463, we find that 24 railwaymen were killed in air raids and 97 injured, of which the Great Eastern had 12 killed and 26 injured, and the Midland 10 killed and 27 injured. From details elsewhere we find that 10 deaths and 23 cases of injury occurred on the Great Eastern at Liverpool-street in the daylight raid of June 13th, 1917, and 8 of the killed on the Midland lost their lives when St. Pancras station was bombed on February 17th, 1918. The chapters devoted to the individual work of the various companies are very entertaining, and show that all, small as well as great, did their share. In particular would we refer to Chapter LXV., on the Highland Railway, and the story of the transport of the American troops given in Chapter LXVII. on the London and North-Western Railway.

To sum up the whole matter, we would say that Mr. Pratt has told very concisely and in a remarkably clear way the wonderful story of what the British railways did in the Great War; to quote the subtitle, their "Organisation, efforts, difficulties, and achievements." Most of us were long ago satiated with histories and reminiscences connected with various phases of the war, and they became to us a vexation and a trial. Mr. Pratt's work has, however, made us forget that we were tired of reading of the war; its perusal has left a pleasant memory. To others for whom war literature has no longer any attraction we commend this present work as a safe antidote, whilst to all who like a good story, well told, we submit it as full of interest and instruction.

Lectures on the Locomotive. By Dugald Drummond. Sixth edition. London: The Locomotive Publishing Company. 3s. 6d. net.

It is probably known to a good many of our readers that the late Dugald Drummond, of the London and South-Western Railway, delivered, at various centres, to his drivers and firemen a short course of lectures on the management of their engines. The lectures were so successful that they were issued in book form, and during the lifetime of their author passed through several editions. We are glad to see that another edition, the sixth, has now been issued by the Locomotive Publishing Company, Limited, and is being sold for the benefit of the London and South-Western Railway Servants' Orphanage. Of its kind the little book is pre-eminent. Many engineers know locomotives well, possibly better even than Dugald Drummond, but few of them know so well as he did the attitude of the enginemen and firemen to their engines or can appreciate as fully as he did the powers of comprehension of the men. He knew partly by long experience and partly by an infallible instinct just where they were likely to go wrong, and he had a degree of tact in putting them on the right lines without hurting their susceptibilities that is rarely found. It is in this light that those who are not drivers or firemen themselves should read this little volume. Its intention is to give the enginemen just that degree of knowledge which they require in their daily work, and which will not only increase their interest in that work, but will enable them to go further if they so desire. Drummond, in giving these lectures, was in advance of a movement which gained impetus during the war in a slightly different direction. Then it was found that the output of factories was increased if the object of the operations on which they were engaged was explained to the operators. The interest of the workers was awakened and better work was done. Drummond moved in the same direction. He believed, contrary to the view of Stroudley, that the men would drive their engines the better the better they understood them, and he appears to have been right, for there can be no question that the driving on the South-Western is remarkably good.

Mr. Urie, Drummond's successor, has added in this edition some notes on the Eastleigh superheater, piston valves, lubrication, the Walschaerts' gear, and electricity.

Of course, the whole thing is elemental—we mean elemental rather than elementary—but within its limits it is one of the few really useful practical books on locomotive-engine driving.

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H.M.S. Dreadnought.*

By J. H. NARBETH.

The purpose of Mr. Narbeth's paper was to trace in some detail the following notable steps in British naval construction :—(1) Majestic to King Edward VII. (2) King Edward VII. to Lord Nelson. (3) Lord Nelson to Dreadnought. The paper is of considerable historical interest, but as it is somewhat lengthy we give below only that portion referring to H.M.S. Dreadnought.

The change from Lord Nelson to Dreadnought was very spectacular, in that the mixed armament of the former was replaced by the ten 12in. guns of the Dreadnought, but this involved practically no change of weight.

It has already been pointed out how clearly it had been proved that the armament of a battleship should for ship action comprise only one type—the heaviest guns. The writings of the late gifted Italian constructor, Colonel Cuniberti, prepared public opinion for this change, but it is not considered that his writings influenced the Admiralty to any appreciable extent. The writings of Captain—now Admiral—Sims, of the United States Navy, did, however, make a very deep impression on the mind of Lord Fisher, and very largely supplied the impetus which determined him to ask for a one-calibre big-gun battleship, the feature by which the ship will be best known. Critics and writers of all sorts vied with each other in endeavouring to discover what had been sacrificed to carry this immense armament at the great speed of 21½ knots. It did not, however, appear to have occurred to any of them that the skill of the naval architect and the marine engineer had a good deal to do with it.

The hull of the vessel had the benefit of the great savings on hull which had been accomplished in previous ships : and this may be summarised by saying that the vessel was actually built with a hull of the same weight as that of the Jupiter—"Majestic" class—although the Dreadnought was of nearly 3000 tons greater displacement. The saving on the design of 12in. gun mountings effected at the time of King Edward VII. was also an important help.

Two other very important matters contributed to obtaining the high speed of 21½ knots. It was realised that the ship was of an entirely novel, epoch-making character, and a special effort was made to draft a set of lines which would carry the required displacement on the dimensions provisionally arrived at, with the smallest horse-power practicable. When the model made to these lines was tried in the tank it was found that 23,000 horse-power would suffice for 21 knots, whereas the best estimate that could be made on the basis of previous forms of equal fullness required 28,000 horse-power. This saving of 5000 shaft horse-power meant saving one row of boilers and 25ft. on the length of the ship.

Secondly, the high speed obtained by H.M.S. Amethyst, with turbine machinery, had made a deep impression on the minds of the constructors employed on the work. The Amethyst had developed on three shafts about half the horse-power required, and it was proposed that Parsons turbines, driving four shafts, should be adopted. The Engineer-in-Chief, after inquiry, was able to accept this proposal. Much discussion followed as to the speed at which the turbines were to run. Sir Charles Parsons was able to give very material assistance in this matter, and the design was approved for 23,000 horse-power, to be developed equally on four shafts at 320 revolutions. The installation was a great success, 26,000 horse-power being developed on trial, and a speed of 21.6 knots at 328 revolutions.

By the improvement in the lines, and the adoption of turbines, the 21 knots was obtained for 23,000 shaft horse-power, and this power was obtained on a weight of 1900 tons. Otherwise a much larger vessel would have been required to accommodate the machinery, and a vessel of perhaps 20,000 tons and 30,000 indicated horse-power would have been needed. This was the real reason why the building of the Dreadnought stopped foreign battleship-building for a period, and not the fact that she could carry so many 12in. guns.

Figs. 1 and 2 show how marked was the improvement in propulsion, and how great were the distances the Dreadnought could steam compared with preceding vessels.

The increased length of the ship compared with Lord Nelson, particularly the greatly increased length over the 12in. gun barbettes, necessitated a very large increase in the weight of the armour and of the protective decks. The disposition of the armour was, however, very carefully considered, and as already stated by Sir Phillip Watts, the armour was accepted as sufficient, in combination with the other features of the design ; it had not been cut down for the purpose of reducing the displacement, but the whole of the proposals harmonised well on the outline design put forward and accepted.

The general disposition of guns and armour—Fig. 3—illustrates the dominant idea which always asserts itself when British naval officers are in conference as to qualities of design, and which is embodied in a saying frequently heard in the Navy :

> "Twice blest is he who hath his quarrel just :
> Thrice blest is he who gets his blow in fust."

There can be no doubt whatever that the change from the more extensive armour arrangements of the Lord Nelson was accepted at the time without the slightest qualification or demur by the officers concerned. In order to illustrate this point Fig. 4 has been prepared, comparing this change with the corresponding change which took place eighteen years before, when the Naval Conference adopted the Royal Sovereign, and passed from armour protection of the Trafalgar type, shown at A, to that shown at B, a change of the same character, but much more pronounced than in the change in 1905 from the Lord Nelson as at C to the Dreadnought as shown at D.

By reference to Fig. 3, it will also be seen that the contour of the stem is modified, the idea of ramming being entirely dropped, and the ship confined to gun and torpedo for offence.

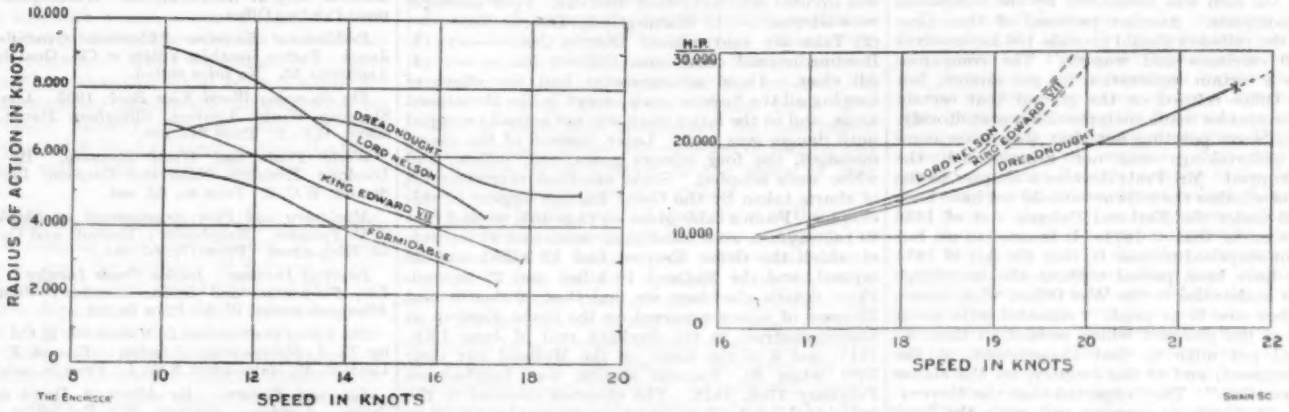
In the working out of the design it was appreciated that the arrangement of masts, fire control, boats and signals would require careful consideration, and a small committee, consisting of Captain Jellicoe, Captain Madden and Captain Jackson, all of whom have since risen to the highest ranks and honours, was deputed to look into these matters very carefully. Nine plans were prepared, showing as great variations as were possible within the limits of the space. These were carefully considered, and as a final result the design embodied a tripod mast standing just abaft the foremost funnel. The lifeboats were handled on each side of the ship by a pair of topping davits, with the heels fitted on the after superstructure above the line of fire of the broadside guns. The heavy boats were handled by hydraulic rams designed to operate the hoist by a single lift and to top the derrickby a double purchase. By this means it was possible to place both rams on the middle deck behind side armour, and the arrangement worked very well.

It was also decided that the ship's outfit should be up to date and that she should be provided with Diesel driven picket boats instead of steamboats, but, as the ship was completed some time before the motor boats, ordinary steamboats had to be supplied.

Two Diesel driven dynamos for emergency service were fitted, thus following the precedent of the Lord Nelson, and although considerable trouble arose in starting, the engines ultimately gave great satisfaction and proved a real boon for use in an emergency, when it was desired to let down steam in all the boilers.

The Dreadnought was provided with the most complete system of net defence ever fitted to a British ship. Particular attention was given to this part of the work by Captain—now Admiral Sir Reginald—Bacon, and a complete system of brailing and hoisting was eventually worked out whereby the leads were taken from the brailing davits to the ends of the booms, down under the nets, and back to the heads of the booms. These brails served to roll up the nets on themselves, and then to hoist them up to the edge of the upper deck right fore and aft in one continuous roll, in a very few minutes, while the reverse operation of letting out the nets was performed in a still shorter time.

Another feature of the topside fittings was the anchor arrangements. The stockless anchors fitted in King Edward VII. were a great success from the navigator's point of view, but the Captain reported that, when at sea, they sent up such an amount of fine spray, that sighting of the forward 12in. guns was very seriously impaired. In the Dreadnought it was decided to amend this if possible. Many schemes were prepared, models made and tested in various ways, and at last it was found that by making the hawse pipes trumpet-shaped, and suitably forming the external portions, the cables could be hove up until the upper fluke of the anchor was actually showing above the edge of the forecastle deck. The head of the anchor was by this plan raised about 18ft., and this proved an enormous improvement. Such an arrangement should be of advantage to ocean liners in reducing the spray cast up



FIGS. 1 AND 2—CURVES SHOWING THE RELATION OF SPEED TO RADIUS OF ACTION AND HORSE-POWER

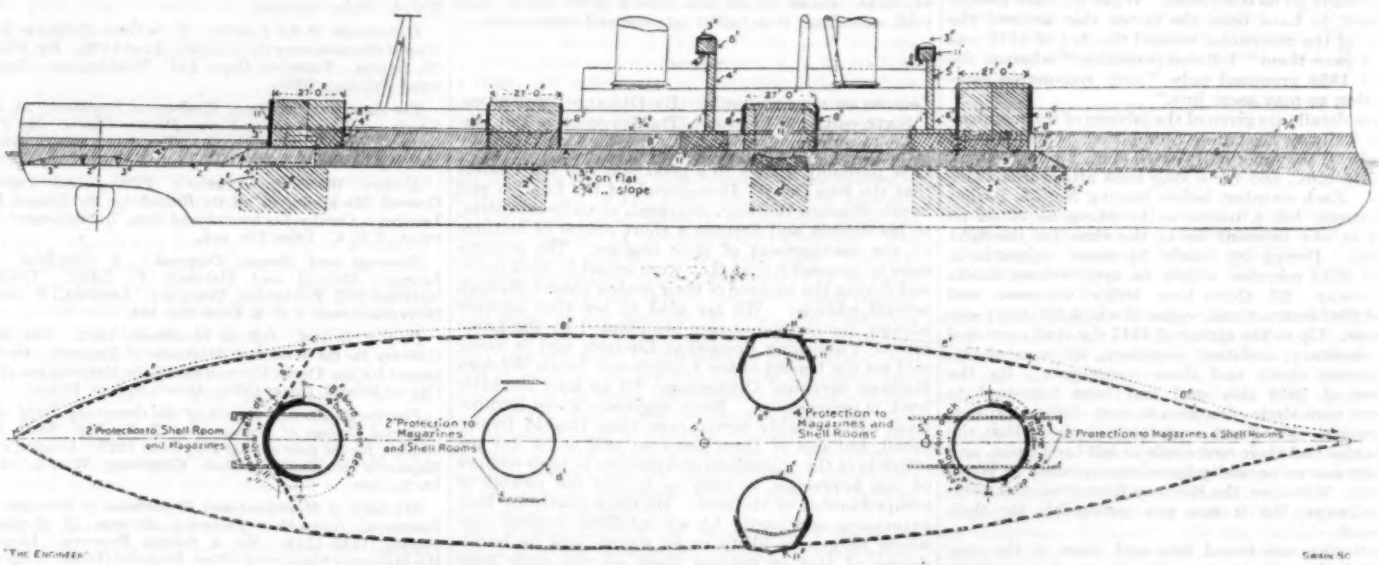

2" Protection to Shell Room and Magazines
2" Protection to Magazines and Shell Rooms
4 Protection to Magazines and Shell Rooms
2 Protection to Magazines & Shell Rooms
"THE ENGINEER"
SWAN SC

FIG. 3—GENERAL DISPOSITION OF GUNS AND ARMOUR ON H.M.S. DREADNOUGHT

* Institution of Naval Architects : from a paper entitled "Three Steps in Naval Construction : King Edward VII., Lord Nelson, Dreadnought."

at sea, but it does not yet appear to have been adopted.

Special attention was given to the steering arrangements. Two rudders were fitted, which were directly in line with the inner shafts and gave very remarkable manœuvring power to the ship. Table II. will be found useful in comparing areas of ruddors, &c., of the various ships named. At the time of the design the only place which could be found for the steering engines was at the bottom of the engine-room bulkhead. This necessitated difficult shafting arrangements with skew gearing. After the first few days away from port it was noticed that the rudders appeared to hang a little. They had been deliberately over-balanced in order to lessen the twisting moment on the rudder-heads when going astern, but events showed that the over-balance was greater than was expected; and although at first no trouble was experienced, it is probable that the skew gearing became slightly deformed, because, after a while, when the rudder was put over at full speed to 35 deg. the engines could not bring it back beyond 25 deg. until the speed had fallen perceptibly. It was afterwards found that in the ship as built, the steam steering engines could be shifted so as entirely to avoid the use of this gearing. Engines of greater power were fitted in the new positions with direct shafting and proved a great success.

A very well-known naval writer and critic of naval strategy and tactics, whose identity was adorned but not hidden by the mystic name of "Maga," discussed the features of the vessel at great length, and concluded that the "enduring mobility" of the ship had been sacrificed, and that it was actually about equal to that of a 74-gun frigate! What this means the author is unable to say, but on her first voyage the Dreadnought went to the West Indies to carry out calibration tests with her 12in. guns and returned at an average speed of 19 knots for the whole distance. On being docked after this, a very remarkable discovery was made: the side plates of the port rudder had opened at the forward end; the forward portion of the frame of the rudder—a steel forging of considerable weight—had been carried away and had passed through what remained of the after part of the rudder, making a very large hole through the plating on both sides. Even with the greatly increased obstruction thus arising, the turbines had kept up the speed of the ship to the figure named above, and although vibration of the port shaft had been noticed, no one on the ship had any idea of what had happened until the ship was docked.

Among other minor matters it may be noted that in the Dreadnought the officers were accommodated forward, the whole of the spaces aft being utilised for the men, for whom improved arrangements were made, including the provision of a large reading-room. This was not altogether satisfactory, as the Admiral's cabins were of necessity in the middle of the working parts of the ship, and the officers' and men's accommodation were not sufficiently separated. The arrangement was not adhered to in the later ships. It may also be, perhaps, of interest to note that a committee on the Royal Naval Medical Service inspected the ship, and Sir Frederick Treves reported upon the sick bay arrangements as being "perfect in position and in everything else."

The vessel carried 2900 tons of coal, 1120 tons of oil fuel, and 120 tons of patent fuel—see Fig. 1 for steaming distances. The disposition of the coal in the bunkers was most carefully considered and the bunkers arranged with the utmost care, in order to minimise the work of trimming coals fore and aft, at the same time keeping the ship on a practically even keel, whether the bunkers were full of coal or quite empty; and this was accomplished. Another matter contributed very largely to the comfort of officers and men on the ship, in that carefully planned arrangements were made for coaling entirely through coaling shoots led to the upper deck. All trunks between decks were either water-tight or dust-proof, so that the inconvenience of coaling was reduced to a minimum; in fact, on the last occasion that the author visited the ship, the vessel was alongside the coal depôt at Portsmouth, and coaling was in full progress while the cabin bulkheads between decks were being re-painted.

It is well known that the vessel was built in record time. In order to facilitate this the hull structure was designed so as to secure the utmost simplicity in every way, and at the same time to provide the exceptional rigidity required in the decks and bulkheads in order successfully to withstand the shock of firing such a large number of heavy guns. The number of steel sections used was reduced to a minimum; and a great effort was made also to adopt plates of the several thicknesses required in standard sizes, so as to avoid the usual labour and waste of time in cutting and sorting plates. Considerable quantities of plates were ordered to standard sizes, settled on, &c., and by this means an ample supply of materials was maintained well in advance of the work on the ship. In the dockyard it might be said that the ship was very largely built from the mould loft, and the excellent work of laying off and preparing the detail drawings was carried out under Mr. J. R. Bond, who afterwards left the Service, but whose splendid work contributed in no small degree to the rapid, economical, and efficient building of the vessel. From Table I. it will be seen that the hull of the ship cost less than that of King Edward VII. or Lord Nelson.

In view of the recent discussion as to framing of merchant ships, it may be remarked that the outer bottom or shell plating of the Dreadnought consists of 25 lb steel plating, and the inner bottom or tank top of 17 lb. plating, while the transverse frames are 4ft. apart. It is regretted that space does not permit a full description and drawings.

As completed, the Dreadnought proved a wonderful sea boat, her sea-keeping qualities being of a surprisingly good character. This was partly due to the following:—(1) High freeboard of 32ft. at the bow. (2) Great flare of the forecastle, the flare being carried as far aft as practicable in the ship, and only reaching the upright amidships. (3) The almost rectangular section 'midships, which offered great resistance to rolling. These qualities in the ship were exemplified during the trials. One morning H.M.S. Hibernia, which was going out for gun trials, passed the Dreadnought, and it was with great surprise that we read in the newspapers the next day that the weather was too much for the Hibernia to attempt her trials. In the Dreadnought the bad weather had not been noticed. As showing the value of the high freeboard, it may be remarked that on one occasion, running across waves about 500ft. long, and 15ft. high, at a speed of 19 knots, when plunging into the crest the green sea came up a few feet above the head of the stem, and, when the ship passed over the crest, the forefoot was fully exposed for 20ft. or 30ft. along the straight part of the keel. There was also a slight sea coming from the starboard bow at the same time, but the vessel was perfectly dry and wonderfully steady. In Table II. are given the metacentric heights of the several vessels which have been named in this paper. After the incidents connected with the rolling of the Royal Oak, bilge keels were added to the Royal Sovereign, and provided for in the design of the "Majestic" class. In addition, Sir William White aimed at a very moderate metacentric height—3ft. to 3½ft.—with the result that the "Majestic" class proved exceedingly steady ships, but the ends were only of ¼in. plating, and on one occasion one of the vessels was rammed by a picket boat at Malta and holed at the water line, causing some alarm. To prevent damage of this kind occurring again, the thin plating at the water line forward and aft was sheathed with wood. This sheathing was interpreted as an aid to stability, from which it was deduced that the vessels were deficient in stability, and although the vessels were most excellent sea boats, the belief appears to have been retained in the Navy to the end. It is notable that with increasing metacentric heights the effect on rolling was not perceptible until the "King Edward VII." class was reached, and these ships rolled perceptibly sooner and more quickly than the other vessels. Information as to the actual periods of rolling of the ships is very confusing, but it has been established that the period of the Dreadnought is 13¾ seconds. While in company with other vessels of earlier types than Lord Nelson, her rolling is very much less on account of the great resistance offered by the square form of her section, notwithstanding the increase in metacentric height.

A further remark may, perhaps, be made as to the cost of H.M.S. Dreadnought. When the Committee on Designs had before it the suggestion to fit turbines for propelling machinery the question was immediately raised as to what would be the effect upon the vessel, and the reply was that the adoption of turbines instead of reciprocating engines would mean an aggregate saving of 1000 tons in displacement and £100,000 in cost, and this was actually realised. The original estimate of the cost given on that occasion was £1,785,000, while the actual cost of the vessel as built was £1,784,000, made up as shown in Table I. Costs of the other vessels are also given for comparison in the same table.

The Dreadnought as completed for sea floated at a mean draught of 25ft. 5½in., the trim was exactly as designed, and the metacentric height very slightly greater than the estimate. The variation of draught with the quantity of fuel actually on board has been the cause of some confusion. For instance, in the United States it was officially stated, when discussing their proposed vessels, that the Dreadnought, when completed, was 12in. deep; the Stability Statement* shows that this was not the case.

During the building of the vessel continuous inquiry and investigation proceeded, and no less than twenty-five alternative sketch designs were produced and submitted to the Board of Admiralty before the next ship was ordered. These designs showed considerable variations of guns and armour, but in the end, after the successful trials of the Dreadnought, it was decided to build three other vessels of the same type, Bellerophon, Téméraire, Superb, in which minor variations were made. The displacement was increased to 18,600 tons, chiefly in order to provide additional torpedo-defence bulkheads throughout the length of the citadel, and an improved anti-torpedo boat armament of sixteen 4in. quick-firing guns. There were thus four vessels of the class. The torpedo-defence bulkheads were constructed of 3 per cent. nickel steel, a magnificent material having a high yield point, and rivets of the same material gave very fine connections.

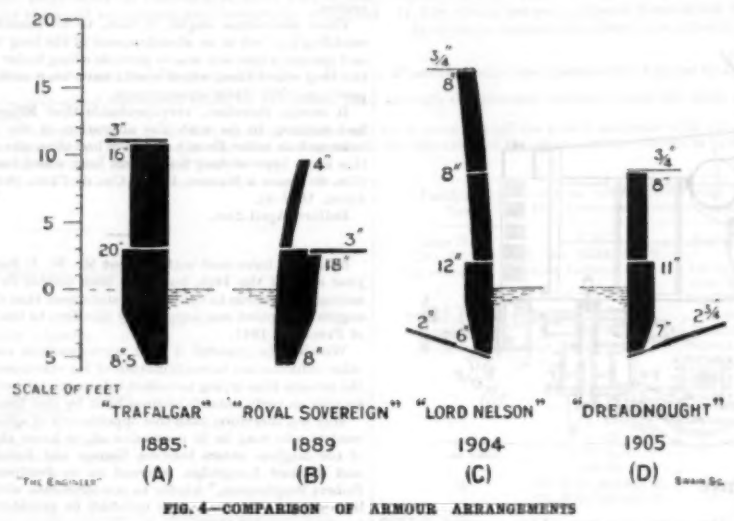


FIG. 4—COMPARISON OF ARMOUR ARRANGEMENTS

TABLE I.—*Showing Actual Cost of Ships Named.*

Item.	Majestic.	Formidable.	King Edward VII.	Lord Nelson.	Dreadnought.
	£	£	£	£	£
Hull and armour	668,201	704,919	389,172 426,272	422,060 412,077	381,208 471,516
Machinery	84,526	154,601	240,512	214,518	319,585
Gun mountings and shields	86,104	75,585	221,229	460,375	382,205
Total	838,831	935,105	1,277,185	1,509,030	1,554,514
Guns	57,300	74,500	89,400	110,400	111,400
Incidental charges	77,551	87,640	105,490	31,909	117,969
Grand total	973,682	1,097,245	1,472,075	1,651,339	1,783,883

Although Lord Brassey advocated the building of small battleships, he was fully convinced of the merits of the Dreadnought, and speaking on December 22nd, 1908, stated the general view of the results reached as follows:—"Our Dreadnoughts have more than fulfilled the highest demands or expectation formed of their fighting efficiency. They steam 21½ knots. In armour and armament they

TABLE II.—*Some Particulars Respecting Form and Performance of Typical Ships.*

	Royal Sovereign.	Majestic.	Formidable.	King Edward VII.	Lord Nelson.	Dreadnought.
Block coefficient	0.648	0.646	0.653	0.645	0.666	0.590
Prismatic coefficient	0.689	0.688	0.684	0.680	0.695	0.606
Area of rudder, square feet	217.4	227.8	226.5	252.5	257.0	2 in No. each 170.0
Ratio of ditto to M.L. plane, 1 to	47.9	47.8	46.8	44.3	42.3	38.0
Axis from fore edge	—	—	—	5ft. 8in.	9ft.	5ft. 4in.
Centre of area from fore edge	8ft.	8ft. 3in.	8ft. 5in.	9ft. 11in.	11ft. 10in.	7ft. 6in.
Diameter of rudder head	18in.	18in.	19in.	18in.	13in.	16½in.
Diameter of pintles	2 in No. each 6in.	2 in No. each 6in.	2 in No. each 6in.	7in.	12in.	—
Tactical diameter in yards with 35 deg. helm at 12 knots	480	493	461	460	395	455
Ratio to length (between perpendiculars)	3.09	3.9	3.45	3.24	2.89	2.78
Metacentric height (G.M. in load condition)	3.60	3.41	4.46	5.30	3.42	5.07
Maximum G.Z.	2.19	2.00	2.61	3.23	2.22	3.06
At degrees	37	38½	37½	36.5	33½	33
Range—degrees	63.2	61.5	65.2	66.5	57.5	63
Area of each bilge keel, square feet	600	600	600	640	640	670
Period of double roll, seconds	16	16	14	14	15	13½
Full-power trial: results—						
I.H.P.	13,300	12,000	15,511	17,869	17,455	26,350
Speed	17.5	17.0	18.13	18.7	18.7	21.6
Revolutions	106	106	109	117	125	328
Steam pressure, pounds	155	155	300	210	275	250

* Given in the original paper, but not here reproduced.—ED. THE E.

are second to none. Costs of construction for the "Dreadnought" class are less in England than elsewhere."

While other countries quickly followed the "Dreadnought" type, it is remarkable that France, after full consideration, decided that it would be better to repeat the "Lord Nelson" type, and accordingly built the "Voltaire" class. The U.S.A. followed by building the "Michigan" class carrying eight 12in. guns at 18.5 knots, but soon adopted in the "Delaware" class ten 12in. guns and 21 knots, as in the Dreadnought.

A French Petrol Locomotive.

It is generally conceded that, for factory and yard service, as well as for light shunting operations in and around stations and docks, the internal combustion locomotive possesses certain advantages over the steam locomotive. Chief among these advantages are its availability for immediate service at any time, and the practical absence of stand-by losses, as compared with those of a steam locomotive which is employed intermittently on very varying loads.

Among the latest manufacturers of motor cars to turn their attention to the application of the petrol engine to the propulsion of small locomotives for industrial purposes is the famous French firm of Renault, of Boillancourt. To it and to our esteemed contemporary, *Le Génie Civil*, we are indebted for particulars of a new petrol locomotive which has recently been completed and tested. This locomotive, which we illustrate in Figs. 1 and 2, has the following leading dimensions:—Length over buffers, 7 m. (22ft. 11¼in.); extreme width, 2.22 m. (7ft. 3½in.); extreme height, 3.275 m. (10ft. 9in.); wheel base, 2.6 m. (8ft. 6in.); wheel diameter, 1 m. (3ft. 3½in.); gauge, 1.445 m. (4ft. 9in.). The chassis is constructed of cast steel, with the longitudinal members placed inside the wheels. The chassis and machinery complete is mounted on springs, and the four wheels all coupled. The model is known as the 19-ton model, that being its total weight. The engine is designed to develop 60 horse-power at 1200 revolutions per minute, and to be capable of hauling a train of about twenty-five wagons, of a total weight of, say, 300 to 350 tons, at a speed of 60 kiloms., or, say, 37 miles per hour on the level.

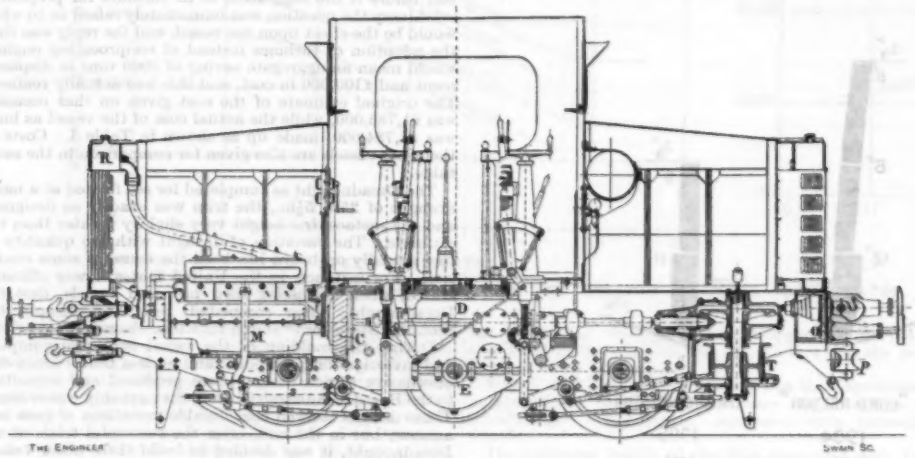


FIG. 1—RENAULT PETROL LOCOMOTIVE

As will be seen from the longitudinal section shown in Fig. 1, the motor M is placed at one end of the chassis. The cylinders, which have a bore of 110 mm. ($4^{5}/_{16}$in.) and a stroke of 160 mm. ($6^{5}/_{16}$in.), are six in number, and are cast in two blocks of three each. They are cast complete with their water jackets and are bolted direct to an aluminium crank case, which is jointed on the centre line of the crank shaft. The crank shaft is made from nickel steel, and is supported on seven bearings with bronze liners. The connecting-rods are drop-forged and of the straight type, while the pistons are of malleable iron. The valves, which are made from high-tensile nickel steel, are inclined to the vertical axis of the cylinder, so as to reduce the clearance in the valve chest.

The cams and cam shaft are machined from the solid. Forced lubrication is fitted throughout, the lubricating pump being drowned in an oil tank in the crank case, and being driven from the cam shaft through gearing. The silencer is shown at S in Fig. 1.

The following table gives the makers' figures for the performance of this locomotive:—

	First speed.	Second speed.	Third speed.	Fourth speed.
Speed in m.p.h.	2.5	4	7	12
Drawbar pull in lb.	6210	3770	2070	1240
Tonnage hauled—				
On level	277	168	92	55
3 per cent.	58	30	11.8	2.9
5 per cent.	33.5	15.7	2.9	—
8 per cent.	17.7	4.9	—	—

The carburetter, which is of a specially adjustable type, is in such a position as to be readily accessible for cleaning. The high-tension magneto is driven through a series of helical gears. The engine is governed for a speed of 1200 revolutions per minute by a centrifugal governor fitted for this purpose. Cooling is effected by means of a radiator shown at R, the air circulation being maintained by means of the fan C. The clutch is of the inverted cone type, fitted with a Ferodo lining. The gear box is arranged for four speeds, and reverse. The reducing gear, which is shown at D, transmits power to the axle E, which is provided with two crank discs, which, in turn, are connected to the driving wheels by coupling rods. Two brake shoes are fitted to each wheel and the brake mechanism is operated by means of lever mechanism from two horizontal hand wheels in the cab. The front and back wheels may be independently braked as required. Sanding arrangements, controllable from the cab, are provided for each wheel. At one end of the chassis there is a cable drum T, which is capable of carrying 50 m. (160ft.) of cable. It is actuated by gearing from the main drive, and may be controlled from the cab.

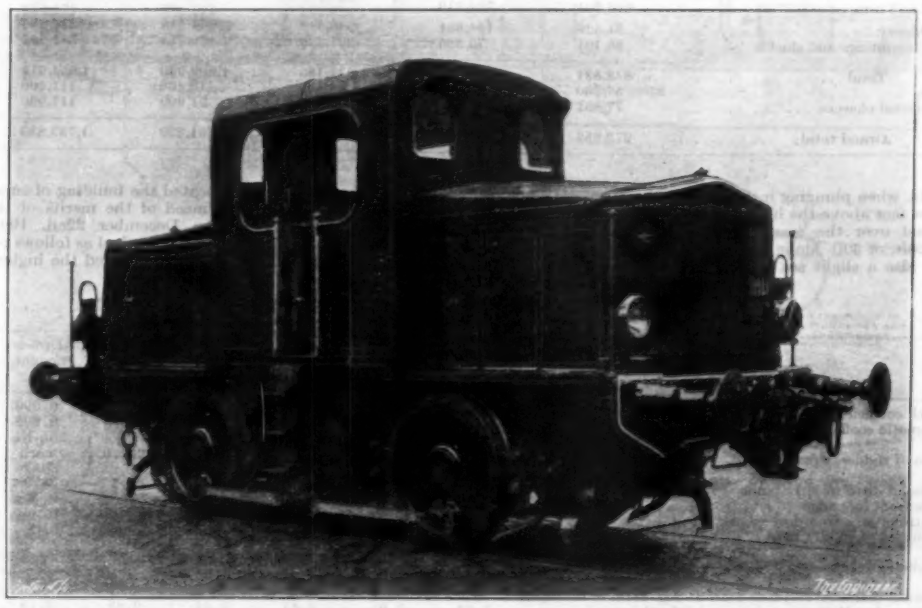


FIG. 2—RENAULT 19-TON PETROL LOCOMOTIVE

Fairleads P are mounted on brackets attached to the buffer beam. This arrangement has been adopted for the purpose of manœuvring wagons during shunting operations. The cab is at the centre of the locomotive, and the driver has full view of the lines in both directions. The controls for reversing, for the clutch gear, for the gas and air, as well as those for the brakes, sand boxes, and cable drum, are arranged within reach of the driver.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

STEPHENSON LONG BOILER ENGINES.

Sir,—I have read in THE ENGINEER for April 14th, 1922, the letter of Mr. W. J. Barker, concerning the old long boiler engines of the Chemin de Fer du Nord. I want, in order to prevent the perpetuation of a mistake in the matter, to correct some statements of the above letter.

(a) The illustrated engine was not supplied by Messrs. Stephenson and Co., who did not supply any locomotive to the Cie. du Nord. The engines of the class depicted (Nord 51–121) were all supplied by French firms.

(b) The engines were originally built as classical long boiler engines, with all the axles under the boiler barrel (total wheel base 3140 mm.), most probably to drawings supplied by Messrs. Stephenson.

But the engines having proved unsteady, the Cie. du Nord altered them in 1849–1850, by putting the trailing axle behind the fire-box, and at the same time increasing the distance from leading to driving axle, and also the driving wheels diameter (1739 mm. instead of 1680 mm.). The illustration given by Mr. Barker applies, therefore, not to the original, but to the rebuilt engine.

These alterations ought, in fact, to be considered not as a modification, but as an abandonment of the long boiler principle and patent, whose aim was to provide a long boiler barrel without the long wheel base, which would have been necessary with the previous (1835–1840) arrangement.

It seems, therefore, very probable that Messrs. Stephenson had nothing to do with the alteration of the Nord engines, inasmuch as other French railways had then already introduced this same type of long boiler and long wheel base locomotives (Cie. de Tours à Nantes, 1847; Cie. de l'Est, 1848; Cie. Paris-Lyon, 1847–8).

F. ACHARD.

Belfort, April 21st.

Sir,—We have read with interest Mr. W. J. Barker's letter in your issue of the 14th, but have been unable to find anything among our records to confirm his statement that the remarkable engine illustrated was supplied by this firm to the Nord Railway of France in 1847.

We shall be grateful if your correspondent can give us any other information in confirmation of his statement, as we are at the present time trying to collect information from contemporary sources on early notable engines built by this firm.

May we, therefore, take this opportunity of asking any of your readers who may be in possession of, or know the whereabouts of the original letters between George and Robert Stephenson and Michael Longridge, referred to in Jeaffreson's "Life of Robert Stephenson," kindly to communicate with us. If these letters are still in existence we shall be grateful for an opportunity to inspect them.

For ROBERT STEPHENSON AND CO., Limited,
C. N. GOODALL,
Managing Director.

Darlington, April 22nd.

MARINE DIESEL ENGINES.

Sir,—On page 445 of the April 21st, 1922, issue of your esteemed journal is published an abstract from my contribution to the discussion of Mr. James Richardson's paper on "Diesel Machinery for Single-screw Motor Ships," read before the Institution of Naval Architects.

In this abstract it is stated that: "Baron Steinheil did not believe in twin-screw installations for ships above 7000 horse-power." This is incorrect, as I said: "That I did not agree with the author with regard to his ideas of necessity for twin-screw installations for ships above 7000 tons deadweight capacity." I also gave a comparison between twin-screw and single-screw installation in a ship of 10,000 tons deadweight capacity, and showed that by adopting two-stroke cycle a single-screw arrangement is quite possible with an engine-room of practically the same size.

In your abstract you also state that "I am in favour of independently driven engine-room auxiliaries, which should be provided in duplicate," and "that electrically driven auxiliaries were expensive." This statement is also not quite correct, because what I said was that "I quite saw the point of some marine engineers insisting upon all auxiliaries being driven independently of the main engines and, whenever possible, provided in duplicate. With such an arrangement the main engines need not be stopped so as to repair any breakdown in auxiliaries, as the standby unit could be started at once and the broken part be repaired at leisure. The idea of electrically driven compressors and scavenging pumps either as turbo blowers or as reciprocating machines has many good points, and one of the most important is that of a good load factor on the electric generating sets irrespective of whether at sea or in port; but such an arrangement is rather expensive and considerably complicates the installation. Personally, I prefer to have all the auxiliaries driven direct from the main engines, because cases of breakdown of scavenging pumps and air compressors nowadays are very rare."

I hope you will be able to give publicity to the above remarks.

London, April 21st.

G. J. STEINHEIL.

PATENT OFFICE METHODS.

Sir,—I ask your help in giving publicity to an example of bureaucratic high-handedness on the part of the Patent Office. Fifteen months are allowed from the date of the application for a patent to that of its acceptance, with a proviso that a patentee may apply, on a form carrying a £2 stamp, for one month's extension, repeating this, if necessary, a second and third time. In the case I refer to, over twelve months elapsed from the date of application before the first comments were received from the Patent Office, and these were replied to in fourteen days. Two months later further comments were received, accompanied by a suggestion that, as the time left was short, an extension should be applied for, on the terms above-named. It was pointed out to the Comptroller that, as his office was responsible for fourteen out of the fourteen and a-half months that had gone, it was monstrous that the patentee should be asked to pay for an extension. His reply was a recapitulation of the regulation and a printed notice that there had been an unusual pressure of work since the war.

A patentee pays substantial fees, in return for which he has

a right to expect due attention, and, judging from the long list of the staff given in "Whitaker," it ought not to be difficult to provide it. In any case, the patentee ought not to be mulcted because the Patent Office cannot get through its work in a reasonable share of the time allowed by the regulations.

JOHN G. HUDSON, M. Inst. C.E.

Bolton, April 15th.

[The Comptroller is obliged by the rules to call for the extra fees, but we believe he has the power to allow for the extra stamps at a later stage.—ED. THE E.]

AVOIDABLE WASTE IN LOCOMOTIVE OPERATION.*

SIR,—Results quoted from tests of locomotives effected on the rollers of the laboratory at Altoona, Pa., and reproduced generally in the leading engineering papers of the world, have created much interest from the particularly low figures of consumption that have been selected solely from the minimum figures that are, on such plants, exceptionally arrived at, as, for example, 15.4 lb. steam per indicated horse-power hour in the P.R.R. goods engine, Class I 1 s, weighing over 160 tons without tender.

These figures show what low figures may be attained in the still, warm air of a laboratory with a fixed locomotive running on rollers. On the road, in ordinary service, from 15 per cent. to 20 per cent. more must be reckoned as their normal consumption under the most economical and favourable conditions of working.

Recent American and European Methods of Avoiding Waste in Locomotive Operation as Affected by Design.

Only the autographed records as made by the steam itself through the pressure indicator form the basis of the following computations

Observe, in locomotives, as in all reciprocating engines, (*a*) for a given cut-off the power increases with (1) each increase in the rate of expansion; (2) increase in the time during which the operation of the steam on the pistons is prolonged; (*b*) by lower engine speeds; (*c*) by multiple expansions.

"Pacific" type express locomotives with Schmidt superheaters by the American Locomotive Company.

	Erie R.R. No. 50,000 On rollers in Altoona Laboratory	P.R.R. No. 3395, K-29	Scandinavian Railway — On open road in winter, new, hitherto untested, experimental locomotive
Railway			
Locomotives			
Where tested and cards made			
Cylinders	27in. × 28in.	27in. × 28in.	Same size cylinders
Maximum boiler pressure	205 lb.	205 lb.	185 lb.
	Steam exhausting direct to air		Steam utilised for power in second pair of cylinders, 2.6 times larger
Actual boiler pressure per card	—	201.2 lb.	185 lb.
Superheat temperature	—	+ 231 deg. Fah.	+ 231 deg. Fah.
Cut-off from boiler	(?)	0.31	0.40
Expansion in each cylinder	—	3.22	2.5
Total expansion of the steam	—	3.22-fold	9-fold
Cylinder initial pressure	—	180 lb.	180 lb.
Total M.E.P. as indicated	(?)	67.9 lb. per sq. in.	122.33 lb. per sq. in.
M.E.P. per one-tenth of cut-off	—	21.9 lb. per sq. in.	30.58 lb. per sq. in.
Ditto ditto percentage increase by utilising exhaust steam	—	—	39 per cent.
At revolutions per minute	(?)	180	183
Actual indicated horse-power	—	1978	3620
Net steam per I.H.P.-hour, calculated from cards and by steam tables, "Marks and Davis"	16.85–16.5	16.4 lb.	11.5 lb.
Power at 0.40 cut-off, revolutions 180 per minute, 200 lb. boiler pressure, per Bulletin No. 65	—	2242.6	—
Net steam consumption per I.H.P.-hour, per Bulletin No. 65	—	19.32 lb.	—
At 0.40 cut-off—Increased power by utilising exhaust steam	—	—	+ 1380 I.H.P.
Increased power percentage increase	—	—	60 per cent.
Decrease of consumption by utilising the exhaust = 19.32 — 11.5 ÷ 19.32	—	—	40 per cent.
		Per indicator card No. 19a	Per card No. 5

During the war the Italian State Railways imported the most efficient type of American Schmidt superheater locomotive and worked it at that rate of cut-off which actually gives the highest possible coal economy and equal to that found for the "limited cut-off" locomotives I i s of the P.R.R.—that is, with a 2.5-fold expansion. The engines at first consumed more than the similar type of Italian Schmidt superheater locomotives, but after some modifications had been effected they were enabled to work at practically the same fuel consumptions as the Italian-designed engines, the average water rate during the tests being then about 21 lb. per indicated horse-power.

From the tests made at Altoona it is the common practice of writers and of lecturers to select only the extreme minimum figures of coal and water consumptions realised. Electricians usually quote the highest annual figures of consumption which they can trace. Both practices are misleading—with a purpose in view.

In the table above I intentionally chose the extreme minimum figure of consumption attained in only one test out of eighteen tests made in the still air of the Altoona laboratory excepting those in which "avoidable waste in locomotive operation as affected by design" is met by utilising the exhaust steam for power purposes, when, as shown in this analysis, Bulletin 65, the average of all tests made with theoretically dry saturated steam (not superheated) is 18 lb. (the Bulletin erroneously calls this engine "superheated," although showing the steam to be only just "dry").

Power Indicated per Ton of Engine Loaded.

	P.R.R. No. 3395, K. 29, exhausting direct to air.	Same, utilising exhaust for power.
Weight	142 tons	(?)
Horse-power indicated per ton of engine loaded at maximum economy 1978 ÷ 142 =	13 I.H.P.	General average in Europe for superheated st'm, 23 I.H.P.
Maximum horse-power per ton of engine loaded	17 I.H.P.	—
Maximum horse-power per ton of engine loaded, saturated steam, Portuguese State Railways, Series 401–408, 2250 I.H.P. ÷ W : 75 T	—	30 I.H.P. (twice American output)

NOTE.—The records of very high economy at Altoona are obtained at low speeds. The economy decreases as the speed increases up to the normal speeds usual for the classes of engine tested. It also increases as the cut-off is reduced below 30 per cent. or is increased over 35 per cent. for passenger engines and over 40 per cent. for goods engines. The high consumption obtained with foreign locomotives on the same plant are obtained at higher rates of speed.

* See page 446, paper by James Partington, American Locomotive Company, read before the Railroad Division of Am. Society M.E.

This relates to the Von Borries compound engines, Class 8, of the Hannover Division of the Prussian Railways, as it was exhibited at St. Louis—an engine of 59 tons loaded—later on reproduced as Class 9 for saturated steam, with a great increase in the economy and in efficiency; the series 9 hauling the heavy non-stop express trains from Berlin to Hannover (158 miles), consisting of sixty axles or with 640 tons gross weight, so satisfactorily that the Schmidt-Garbe locomotives (exhausting steam direct to air) were removed and the service afterwards worked entirely by these powerful little compound engines. This statement of results at St. Louis with dry steam, in the Bulletin No. 65, should be read again in connection with the very distorted references to those tests which still appear in the engineering Press from time to time for propaganda purposes. The average of 18 lb. of dry steam per indicated horse-power hour is obviously not low for engines using their exhaust steam; but this is explained by the faulty distribution by the unequal loading of the pistons, as also incidentally by the very high average speeds run comparatively to those of No. 3395, K-29, P.R.R.

C. R. K.

GERMAN SUBMARINE BUILDING PROGRAMME, 1914–18.

SIR,—The last issue of THE ENGINEER embodied a very able contribution on the above-named subject. While fully acknowledging the merits of the article in question, may I be permitted to point out that certain of its statistics and statements appear to be open to question?

Your contributor does not appear to be acquainted with the new and important information recently published on the subject of German war programmes of submarine construction. Such information is contained in the 1922 edition of the German naval annual, "Taschenbuch der Kriegsflotten" ("Handbook of War Fleets"). This book ceased publication in 1918, but the revived and revised edition for the current year contains full data relative to the strength, construction and war losses of the German Navy at the conclusion of hostilities. The tables descriptive of submarine construction appear to be derived from official German records, and are at variance in some cases with the details given by your contributor.

For example, the author of "German Submarine Building Programmes, 1914–18," gives us to understand that all the U boats of the classes between "U 160" and "U 212" were to have been of a standard displacement of 821 tons. On this assumption he prepares statistics of the total tonnages built by the various German shipyards or ordered from them. The "Taschenbuch," however, shows that the U boats of the classes "U 160/172" to "U 263/276" were by no means to any standard design; they comprised a variety of types. To quote at random, U 195/200 were to have been cruisers mounting the heavy armament of three 5.9in. guns and six torpedo tubes. The "U 229/246" class was to have displaced 908 tons. In the case of the "U 213/228" class of 1335/1400 tons, the Germans appear to have evolved a design intermediate between the big cruisers of over 2000 tons and the "mittel-U" designs of about 800 tons. Possibly this class was an improvement on the "UE" (U 117/126) series of ocean-going mine-laying boats designed for operations off the United States coast.

Your contributor appears to be in doubt as regards the German total of 810 submarines built both before and during the war and building or on order in November, 1918. He works out a total of 815 boats and says that this figure approximates to the total of 810 boats given by Admiral von Capelle to the Reichstag Committee. The component submarines of Admiral von Capelle's total have been a long-standing riddle, but the "Taschenbuch" now affords us a solution. Comparing the highest-numbered boat in each series as given by your contributor (A) with the corresponding details given by the German annual (B), we get the following statement:—

	A.	B.
"U" series	U 212	U 276
"UA"	(1)	(1)
"UB" series	UB 205	UB 249
"UC" series	UC 152	UC 192
"UF" series	UF 80	UF 92

Addition of the numbers given in column (B) above amounts to 810—exactly the figure given by Admiral von Capelle. Column (A) accounts for only 650 boats, so that there is a difference of 160 between (A) and (B). The discrepancy may, however, be accounted for by the fact that your contributor only brought his summaries down to the boats of the 1917 programme, which were nearly all commenced; he possibly ignored the 220 boats of the 1918 programme, of which, as he correctly remarks, only a few were actually put in hand. Admiral von Capelle's rather grandiloquent total, of course, included the 220 boats of the 1918 programme, the majority of which existed merely as contracts on paper.

Even so, von Capelle's total is not accurate, for he includes one boat which was never built in a German shipyard and which was never incorporated in the German fleet. This boat was U 42, ordered from and built by the F.I.A.T.-San Giorgio Company (now Ansaldo San Giorgio Company), of Spezia, Italy. A daring attempt was made to get this boat away to sea; she was seized in the builders' yard and actually got as far as Corsica before she was arrested by Italian warships and brought back. She was requisitioned for the Italian Navy and re-named Balilla. Her first enterprise as an Italian warship was an attempt to reconnoitre the Austro-Hungarian fleet anchorage at Cattaro, which resulted in her entire loss. U 42 has no right to be included in the German tables of submarines built, and Admiral von Capelle's total of 810 boats should therefore be reduced to 809.

In referring to his tabular statement A, your contributor remarks that the U boats of the "U 160" class were in hand "when war broke out." This is an obvious slip, for it is notorious that the boats of the "U 160/172" class were being completed when the Armistice was signed. Six boats were sufficiently finished to make the voyage to Harwich for surrender; the other six, being in an incomplete state, were broken up in Germany.

Much further comment could be made on this article, but I have already trespassed enough on your space. In conclusion, may I say that these comments are not written for the purpose of depreciating your contributor's remarks, but merely to correct and amplify his statements. He has done us the service of adding to our fund of knowledge concerning the very interesting question of German submarine output during the late war?

MAURICE PREDERGAST,
Editor of "Fighting Ships" Naval Annual.

London, April 24th.

[We are obliged to Mr. Prendergast for his remarks. The obvious slip he kindly draws attention to on Col. 1, p. 433, is regretted. The "U boats in hand of the 'U 160' class when war broke out" should read "U boats in hand . . . when the war ended." Although the article was written before the publication of this year's "Taschenbuch," it is not at variance really with the information given by Mr. Prendergast. Table A only deals with U boats built or building from 1914 to 1918, and does not include the later U boats, which, though projected, were never built or laid down. The reasons for building the smaller "U 160" class after the comparative failure of the larger U boats are correctly given in Col. 1, p. 433. It is interesting to note that "U 135" class, designed to carry two 5.9in. guns, were found to be wanting in stability on completion, and one of the guns and other top weight had to be removed. The article shows how far the Germans had progressed on Admiral von Capelle's programme by November, 1918. Attention is drawn to the statement at the foot of Col. 3, p. 432. There it is shown that, adding to the boats already built or in hand the 220 ordered or to be ordered during 1918, we obtained 816, a total slightly in excess of the 810 claimed by von Capelle. Although U 42 was built at Spezia and taken over by the Italians, she undoubtedly was part of the German programme, and as such was included in tabular statement A. Mr. Predergast's amplification of the article is cordially welcomed.—ED. THE E.]

INSTITUTION OF AUTOMOBILE ENGINEERS' DATA SHEETS.—We have received from the secretary of the Institution of Automobile Engineers copies of the first seven data sheets which the Institution is now issuing to its members. The sheets, measuring 8in. by 5in., are perforated for binding in alphabetical order in a very neat cover of the loose-leaf type. The sheets issued so far give a table of standard gear tooth proportions, a diagram of comparative sizes of gear teeth, a list of spur gear formulæ, a list of bevel gear formulæ, a cylinder capacity nomogram, a diagram showing the speed of a car per 1000 revolutions per minute of the propeller shaft, and a table giving the wheel diameter after allowing for deflection due to load. The data sheets are to consist largely of tables and formulæ prepared by members for their own use, in addition to which there will be included a certain number of text-book tables which are of especial use to automobile engineers. The idea of circulating information in this manner among the members of the Institution is a very happy and useful one, and might, we think, with great advantage be followed by other bodies.

A Rotary Pneumatic Motor.

A little pneumatic hoist which has just been put upon the market in this country by the Sullivan Machinery Company, Salisbury House, London, E.C. 2, is of unusual interest on account of the type of motor used to drive it. The motor, which is of the rotary class, has been used fairly extensively in America, and is embodied in the coal cutters made by the same firm which are employed in some of the Welsh pits. Its construction is, however, unfamiliar to the majority of English engineers, and seeing that it might be adapted to a variety of other purposes where compactness is important, we endeavour to explain below its somewhat obscure action.

The remarkable thing about this motor is that it has

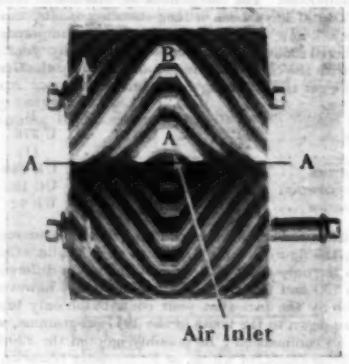


FIG. 1—ROTORS OF PNEUMATIC MOTOR

quite a reasonable efficiency, although it appears, at first sight, to be little more than a gear pump with its function reversed. That is to say, it somewhat resembles a gear pump supplied with a working fluid at the inlet and delivering work instead of absorbing it. In the place of the axial teeth usual in gear pumps, the air motor has, however, double helical teeth, as shown in Fig. 1. This simple change enables the compressed air to be used expansively, and thus converts a machine which would have so low an efficiency as to make it of little commercial value into one which can compete with reciprocating engines as regards economy.

On reference to Fig. 2, which is a sectional diagram taken from one of the coal-cutter motors, it will be seen that the rotors revolve towards the air inlet. The reason why they should do so is not very easy to explain, but considering the matter inversely, it will be seen that if the rotor revolved in the opposite direction the air contained in any one of the tooth spaces would be squeezed out back again towards the inlet by the corresponding tooth of the opposite rotor. On the other hand, with the rotation in the direction shown, there is a steady increase in the volume of the space between any tooth and its corresponding hollow, as it moves from the point of deepest mesh towards the air inlet; so that it is obvious that the latter must be the natural direction of rotation. Such would be the action of a motor with axial teeth, but the efficiency would be ridiculously small, as the air entrapped between the teeth and the casing would be merely carried round to the exhaust port under full pressure. With the double-helical teeth, however, an opportunity is offered for the air to expand and do useful work in the process, so that it is exhausted at a comparatively low pressure. On referring to Fig. 1, it will be noticed that two of the tooth spaces have been painted white, and that the part of A which has passed beyond the meshing plane is not nearly so great as that of B, which is on the point of coming out of mesh. The air in the tooth space is, of course, confined by the outside casing, and thus the air in A will be very considerably expanded by the time it has rotated as far as B. Just beyond B the tooth space is no longer closed by the corresponding tooth of the other rotor, and the air escapes to exhaust at the ends.

Perhaps the easiest way to understand the action is to think of a drum in which is cut a single helical groove running out at one end but not at the other. This drum accurately fits a cylinder of twice its length. Through the wall of the cylinder projects a fixed shutter or piston which just fits the groove. Imagine now that a puff of compressed air is admitted between the blind end of the groove and the shutter. Its effect will obviously be to drive the drum axially, and at the same time rotation will be caused by the reaction between the shutter and the walls of the groove. Now suppose that the shutter can move axially but that the drum cannot. Rotation would still take place. Let us move a step further and imagine that the shutter, instead of moving axially, moves in a helix counter to that of the groove in the drum. It is still obvious that the pressure of the air on the shutter would cause rotation of the drum with endwise movement of the shutter. If, finally, in place of the sliding shutter, we use a rolling one, we have one half of the motor. The addition of the other moiety clearly does not affect the action except in so far as it prevents end pressure.

It will be readily appreciated that the economy of these motors largely depends upon the tightness with which the two rotors mesh together and the tightness of their fit in the casing. Great pains are taken to form the teeth of the gears as accurately as possible, and they are finally ground together in pairs. Each pair is so marked that they may be re-assembled with the proper teeth in mesh. We tested a pair of rotors for clearance and found that a single thickness of fine cigarette paper would just pass through the gear, but that two thicknesses would be crushed. The clearance between the rotors and the casing is, we were told, just over one-thousandth of an inch, but this one is not so important as the clearance between the teeth, as any air escaping between the tops of the teeth and the casing only passes on into the next working space.

In connection with these clearance dimensions an unexpected trouble which developed in the early motors is worth mentioning. The rotors were found to foul the casing badly when the air was turned off to stop the motor. What happened was that the momentum of the rotors kept them running, and they acted as a pump, creating a vacuum on the inlet side, while the exhaust was open to atmosphere. The atmospheric pressure was sufficient to bend the rotors, stiff as they are, and bring them into contact with the bottom of the casing. The remedy was to put a non-return valve into the inlet chamber, which admitted air and broke the vacuum when the compressed air was cut off.

Each of the rotors is made in three pieces, two outside helical gears of cast iron and a plain-tooth centre piece of steel which works opposite to the air inlet and acts as the cut-off valve. Only one of the cast iron sections is keyed on to the rotor shaft, and the other two are bolted to it

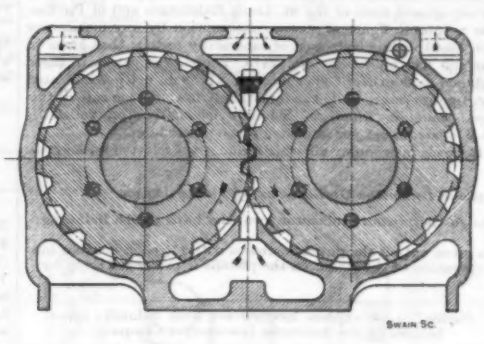


FIG. 2—SECTION THROUGH PNEUMATIC MOTOR

after the two rotors have been carefully meshed together.

The capacity of these motors is remarkable, a feature which may be judged from the fact that the little hoist shown in Fig. 3 contains one of well over 6½ horse-power. The rotors in this case are 4¼in. in diameter at the pitch circle by 6¼in. long. They are mounted on ball bearings and the rope drum is bored out inside to form the casing in which they run. The rotors thus turn with the drum besides rotating on their own axes. Within the drum there is also space for a train of triple-reduction gearing connected with one of the rotor spindles. The last shaft of this train protrudes through the end of the drum, and is furnished with a pinion that meshes with an idler running on a stud fixed near the edge of the end of the drum. This idler meshes in turn with an internally toothed ring

FIG. 3—ROTARY PNEUMATIC MOTOR HOIST

which can be gripped by the brake band seen on the far side of the machine in Fig. 3. When this brake is applied the ring is held, and the idler, driven by the motor, climbs round inside the ring and drives the drum. With the brake slack, the ring turns instead of the drum, or, if the air is turned off, the rope can be unwound from the drum freely. The brake on the opposite side of the machine acts directly on the drum, and is used in lowering or holding the load.

The ratio of the gearing, which is of hardened steel, is 128 to 1, so that with the motor running at about 5600 revolutions per minute, the drum revolves 44 times per minute. All the shafts are fitted with ball bearings, and provision is made for lubricating them. The rotors are lubricated by oil entrained by the air, which is admitted through the hollow trunnion of the drum. The joint between the fixed and rotating parts of the inlet is made air-tight by means of a cup leather.

In Fig. 3 it will be noticed that the hoist is fixed on a mining column, but its frame is so designed that it can be bolted down to a flat foundation if it is so desired. It weighs only 285 lb., but is capable of a direct vertical lift of 2000 lb. when supplied with air at from 50 lb. to 75 lb. per square inch pressure. With the higher pressure the rope speed is 110ft. per minute. The drum is 9½in. in diameter by 9½in. long, and will accommodate 500ft. of $^{5}/_{16}$in. wire rope. The overall dimensions of the winch are 22½in. by 13½in. by 17½in. The makers give the capacity as 6½ horse-power, but as this is reckoned from the work delivered to the rope, the output of the motor must be considerably greater on account of the large ratio of the gearing. Even working on the lower figure the air consumption of the machine is very satisfactory, as it is, according to tests made by the makers, 25.3 cubic feet of free air per minute, at 75 lb. pressure, per horse-power.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Better Trade.

The pessimists are not being allowed to have it all their own way on the Birmingham iron market, nor are they going to be permitted to control affairs. That is the determination freely expressed this week by some of the most live members of the market. Some traders will have it that improvement is already appearing, and, to be candid, they are not far from the truth. Things are decidedly looking better, by which I mean that there is a more satisfactory undertone, and although certainly the manufactured ironworks are not receiving any increase of orders at present, there is a belief, which in certain quarters amounts even to confidence, that very shortly order books will show something decidedly better. Several circumstances inspire a more hopeful feeling, particularly the steady inflow of inquiries, especially on foreign account, and the firmness of prices in all departments, except that of wrought iron. Though the actual business accruing at present from these inquiries is small, it is regarded as the precursor of more extended buying. Unemployment is surely, if gradually, becoming less, and several of the leading industries of the district have been better employed during the past few weeks. The heavy engineering industry is slightly better, the tube trade is buying considerably more material and the motor business is at the height of the seasonal demand and is calling for fairly large tonnages of material. Some heavy edge tool firms have well-filled order books, and with the ousting of foreign competition at home there seems to be every prospect of our now going forward. Mr. H. C. Cole Eatop, of Ohio, at a meeting of the Staffordshire Iron and Steel Institute, recently made some interesting remarks on the future outlook of the iron and steel industry of this country. On the whole, he said, in the light of such knowledge of the iron and steel industry of this and two or three other countries as he possessed, he saw light ahead for British iron and steel. This was because the initiative in competition, which was lost last year, had, to a large extent, been regained as the result of the drastic liquidation of cost factors, and, consequently, prices, which had taken place recently. The British iron and steel business was setting its house in order and was reaching a basis on which business could be done. The industry was now in a position to compete and hold its own in the world.

The Engineering Trouble.

Unhappily, expectations of an early settlement of the dispute in the engineering trade have been disappointed. It is recognised, however, that the negotiations in a case like this are necessarily complicated and beset with difficulty, and that it will require patience and tact to get them reopened and pursued to a satisfactory conclusion. But so much depends upon this that Birmingham manufacturers are agreed that the effort must be made. The restoration of trade confidence is contingent on industrial peace. The opinion is expressed in this district that the employers could not go beyond the line they have already indicated. The unions' attitude is considered both impracticable and dangerous, and manufacturers and masters are of opinion that the battle now proceeding is for the control of the shops by the unions. Members on 'Change this week hold that engineering employers ought to maintain managerial rights and decide the internal policy of their workshops. If every instruction given by the administrative side is to be subject to challenge and question, they say, there can be neither harmony nor continued output. All work would be impeded; it would be impossible to deal with contracts with the necessary expedition. Opinion as to the chances of an agreement being reached before the notices are due to take effect is divided, but on all sides it is hoped that some way will be found to avoid the rendering idle of a further half a million workers.

Quiet Pig Iron Market.

A quiet trade is being done by the pig iron makers in the Midlands sufficient to absorb their output, and the American coal strike has brought some inquiries to this district; but it is doubtful whether these will lead to business, in view of the high cost of conveyance to the coast. The general tone is much more hopeful, and a steady improvement is anticipated with some confidence. The owners of blast-furnaces are disposing of their output, and one Northamptonshire firm is stated to be considering the lighting up of an additional furnace. The weakest department of the market is that of forge material, owing to the stagnant state of the iron trade. The relatively strong position in Cleveland now that the shipments have opened out again has less significance for Midland furnace owners to-day than in times of low railway rates. But the displacement of continental pig iron by the home production, which has given the Cleveland furnaces their

present ascendancy, is bound to have its effect further south if industrial peace can be achieved. Prices remain firm. Encouragement is derived from the export figures, which continue to show a decided improvement. The March exports of forge and foundry pig iron, for example, total 11,509 tons, as compared with slightly under 3000 tons for the corresponding period of last year. For the three months the export tonnage was 37,000, as against slightly under 15,000 for the same period of 1921.

Manufactured Iron.

The manufactured iron trade of the district remains exceedingly dull, and there is little call for either best or common bars. The engineering labour trouble is seriously affecting the former, and the small demand made by the nut and bolt industry, which continues very poorly employed, is being keenly felt by the latter. The recent reduction of £1 in the price of best bars has failed to stimulate demand. Belgium is again keenly competing for the few orders which are about for nut and bolt and fencing iron, quoting £9 6s. delivered as against their recent quotation of £9 10s. In the stringency which now exists on the Continent there is no assurance as to when orders placed with Belgium will be executed. Consumers prefer, therefore, to buy what small supplies they need at home. Local makers of nut and bolt iron have accepted business at below the £10 5s. basis. Iron strip is a slightly better market, recent revisions having brought the price down to £11 10s. to £11 15s., making it more worth the while of users to buy it in preference to steel, which has less resisting power to corrosion. The improved demand for galvanised corrugated sheets has led to increased quotations locally, makers quoting £16 10s. f.o.b. Liverpool. Consumers, however, claim to be able to buy at last week's figure of £16 5s. Business is not on a large scale for any particular market, sales being fairly evenly distributed. Inquiries are fairly numerous, but are slow to materialise.

Improved Steel Business.

The steel trade is showing a steady improvement, with firm prices. Constructional engineers are taking more steel and railways are rather better buyers. One rolling stock building firm is becoming busy, chiefly on high-class vehicles for South American lines. There is, however, a good deal of idle plant in the Birmingham neighbourhood. The current quotation of £7 15s. for Welsh billets delivered in this district has been confirmed by a meeting of Welsh steel makers, but some local firms who are well situated continue to quote £8. Certain re-rolling firms are fairly busy, producing about two-thirds of their capacity. The small increase in the price of re-rolled bars is fairly maintained, makers being able to sell at £9 10s. But there are large steel works in the district still quoting £10 as a minimum. Steel makers generally are firmly maintaining prices in view of the high cost of production and the confidence generally held that the end of the lock-out will be followed by increased buying. Unfortunately, the labour trouble has a depressing influence, although the iron and steel trades are not directly affected, the various skilled mechanics being now linked up with the Wages Board. The tube trade is taking fair quantities of steel strip at £10 10s.

Cheaper Electricity for Birmingham.

An important revision of the charges for electricity has been decided on by the Birmingham Electric Supply Committee. Prices for low-tension supplies are to be reduced by one-halfpenny per unit in the case of ordinary lighting, and one-third of a penny for power supplies. The lower tariff has been made possible by the drop in the prices of coal and other materials and in wages. The committee reports that there has been a marked improvement in sales during the past few months, and that it is of opinion that lower charges would assist to some extent to an improvement of trade conditions. There has already been a substantial reduction in the prices for large manufacturing purposes under contract. The effect of the latest reduction will be to restore prices in all cases to the level of those obtaining in 1919.

Trade Boards.

Midland manufacturers who are interested in Trade Boards express much satisfaction at the findings of the Cave Commission upon the working of the Trade Boards system. They state that the report justifies the action that was taken with the intention of getting the law altered. It has long been felt that if the system was to stand it must be made more elastic. The evidence produced before the Commission by the workers, the employers, and by their respective associations was voluminous, and it is felt that the good work which has been done by the Boards should be increased in the future in the light of the information obtained through the Commission.

Staffordshire Iron and Steel Institute.

The report given at the annual meeting of the Staffordshire Iron and Steel Institute last week-end showed a total membership of 305, a decrease of 10 compared with a year ago. The officers elected for the ensuing year were Mr. Paton, president; Mr. Cook, vice-president; Mr. J. Piper, treasurer; and Mr. C. B. Pugh, secretary. The finances were shown to be in a satisfactory condition.

A New Staffordshire Colliery.

A new colliery is being opened at Hilton, on the western fringe of the Cannock Chase coalfields, by the Holly Bank Colliery Company, the deposits of which are stated to be very extensive. Indeed, it is hoped the production may ultimately reach 1000 tons per day.

Stamped Metal Trade Wages.

The Stamped or Pressed Metal Wares Trade Board notifies that, subject to the ratification of the Ministry of Labour, it has varied by way of reductions the minimum rates of wages for male workers in the trade. For skilled male workers of twenty-one years of age and over of certain special classes the general minimum time rate is to be 1s. 4d. to 1s. 8d. per hour, according to occupation and experience, with corresponding variations in the general minimum time rates for male workers of these classes under twenty-one years of age. For all other male workers of twenty-one years of age and over not included in the above special classes the general minimum time rate is to be 1s. 1½d. per hour. Piecework time rates for any class of male worker are to be 15 per cent. above the appropriate general minimum time rate for such class. Corresponding variations are to take place in the overtime rates for all classes of male workers.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER, Thursday.

Iron and Steel.

THE markets here are simply waiting now for a settlement of the engineering dispute, and until it is reached very little movement of any kind can be expected. There is a theory amongst sellers that orders for materials are accumulating, and will be released in a bunch so soon as the engineers get back to work; but whether or not this theory be worth anything it is difficult to say. The more pessimistic amongst us are afraid that a good many orders will be lost, and that when buying begins again it will not be very startling; but perhaps it is just as well to keep up a good heart and to hope for the best. There are, however, many hindrances yet in the way of a revival in the industries of the world, and in regard to this country one of the most serious is taxation.

Metals.

The metal market as a whole is not nearly so depressed as it was before the holidays, but many people think that the present improvement, like several others, is not permanent, but will be subject to another set-back. The prospects for any large increase in the consumption of copper are not good, but it is fairly clear that an increase in production is going on, and probably will go on for some time. These are the basal facts in the situation, and it is of no use to ignore them, as some of our optimists are apt to do. One of the largest consumers of copper now is the electrical trade, and there is no doubt that if no practicable substitute for copper in electricity development is found, there will be an increasing consumption as the world gets into working order again. Hence it is important to discover whether or not the German attempts to substitute aluminium for copper in electrical work will meet with success. So far as prices are concerned, there will be no great difficulty at present, for aluminium in Germany is at only about £20 per ton above the price of refined copper, although here the difference in price is much greater. The American market for copper is reported as steadier, and apparently the price of electrolytic is fairly firm at 13 cents per pound. Here the price of strong copper sheets remains at £88 per ton, but a reduction of ¼d. per pound has been made in the tube prices. The quotation for brass sheets (10 g.) is curiously high, and these cost £3 per ton more than strong copper sheets. There are other anomalies in the list of manufactured metal prices, and it is quite time that they were removed. One can have no faith in prices which do not correspond fairly with one another. The improvement in tin has been well maintained, and many people think that the market will go to £160, but one may be pardoned for doubting whether the improvement in trade is sufficiently established to make the market very safe. If consumption can be increased to cover the present rate of production, the existence of large reserves may perhaps be ignored for a time; especially if the low cost of money makes the holding of these stocks less burdensome. There have been some reports about the stopping of production of tin in the Federated Malay States, but one does not yet know whether it is safe to believe in their truth. The demand for lead keeps up well, and the market has been very firm. The prices have not yet returned to the level seen at the beginning of this year, but the greater part of the loss has been recovered. It is noticeable that the increase in receipts of Australian lead just balances the decrease in the receipts of Spanish lead. The spelter prices have improved a little, and that market now has quite a firm appearance. The galvanising trade is buying for prompt delivery, and is probably rather bare in stock.

Foundry Iron.

The market for ordinary foundry iron in Manchester is now almost at a standstill. There may be a few transactions, but as a rule the owners of Lancashire foundries are out of the market simply because they do not see whence their orders for castings are to come. It is feared now that the lock-out will spread to all the other industries which consume iron and steel, but in any case, even if it should be confined to the engineering trade, the great bulk of the support of the Lancashire foundry trade is withdrawn. It is possible that consumers would still buy pig iron for future use; that is, they would build up a reserve against the time when a rush of orders for castings might be expected; but this course would only be taken if they believed in a rise in foundry iron prices, whereas most consumers believe that prices will yet be lower. Sellers of Midland iron continue to quote £4 12s. 6d. per ton for delivery of No. 3 quality to Manchester, and the price of Scotch No. 3 is theoretically 115s. per ton for the same delivery. Some small concession might be obtained on these prices; but a concession large enough to tempt buyers to place forward contracts is out of the question. Hence it is that buying is now reduced to a minimum in the foundry market. The Cleveland ironmasters have their shipping trade, and the prices of pig iron on the Continent enable this to be carried on. It is indeed reported that the shipments this month are considerably greater than they were in March; but, of course, the actual figures are not yet available.

Finished Material.

The fear of a general lock-out is, of course, reducing what little trade was left in the market for manufactured iron and steel; but so far there has been no change here in the official prices. Some export trade is heard of, but the prices obtainable are very far from satisfactory, and, indeed, if these prices would be taken for home trade business it is quite possible that buyers would be tempted to place orders, even although there may be no present opportunity of using the material.

Scrap.

Trading in iron and steel scrap here is almost at an end. The nominal prices are about 45s. per ton for steel melting scrap, 60s. for heavy wrought iron scrap, and from 80s. to 90s., according to quality, for cast iron scrap. It is, however, difficult to test the reality of these rates, because buyers are perfectly indifferent.

Settlement of the Wages Question in the Cotton Industry.

After negotiations extending over several weeks, the wages question in the cotton trades was amicably settled on Tuesday last. It will be remembered that the employers' proposal was for a reduction on list prices of 50 per cent., but after many meetings with the operatives' representatives the employers agreed to modify this proposal to a reduction of 40 per cent. for six months and a further 10 per cent. at the end of that period. This was accepted by the weaving section of the workers, but was not approved by the spinning section. Ultimately, however, the representatives of the latter decided to accept the amended terms. The news of the settlement has been received with much satisfaction, as there are signs of improvement in the cotton trade, which finds employment for nearly half a million persons.

New Tramways Manager.

The post of general manager of the Manchester Corporation tramways, vacated by the resignation of Mr McElroy, has been awarded to Mr. H. Mattinson, A.M. Inst. C.E. Mr. Mattinson has for some years acted as chief civil engineer to this department. During the war he served abroad in the Royal Engineers, in which branch of the Service he attained to the rank of major. The Tramways Department employs over 6000 men, and the length of single-line track is 220 miles. The annual income is about £2,000,000.

Oldham and Rochdale Water Supply.

The Town Councils of Oldham and Rochdale have decided, subject to parliamentary sanction, to purchase Hollingworth Lake, which, together with six reservoirs on Blackstone Edge, belongs to the Rochdale Canal Company. The lake and reservoirs have a capacity of 1,530,000,000 gallons, and are capable of expansion. They have hitherto been used almost solely for supplying the canal with water, but the demand for this purpose having fallen off, the sale to the Corporations named was decided upon. Hollingworth Lake has hitherto been a favourite holiday haunt for the industrial inhabitants of the cotton towns. The sale is subject to the right of the Canal Company to draw upon the lake for water for replenishment purposes.

Manchester's Municipal Trading Departments.

Like the inhabitants of nearly all other large municipalities, Manchester people are feeling the pinch of high rates and excessive cost of such essential commodities as gas, electricity, and tramway travelling facilities. In order to alleviate the hardships of the community the Tramways Committee last week decided that a sum of £50,000 out of the profits of the department should be handed over in relief of the rates. Last year the tramways undertaking was expected to make what was then an annual contribution in relief of rates, and the sum required of it was £115,000, but the undertaking was not in a position to make such a payment. Since then it had been decided no longer to make demands on the "trading departments" for rate relief, but the £50,000 voted is a part of the debt incurred prior to the latter decision. It was also decided to make an experiment for a period of two months in the reduction of the tramway fares, by which the penny fare will enable passengers to travel a mile and a-half instead of a mile and a-quarter as at present. Following the lead of the Gas Department, the Electricity Committee has also decided to reduce the price of current as from the June quarter. The Electricity Department made a profit last year of £43,229, after meeting all capital charges and income tax, and this amount is to be placed to reserve account.

The Lock-out in the Engineering Trades.

At the present time the prospects of a settlement of the troubles of the engineering trade seem very remote. No part of the country will be more seriously affected than Manchester if the new lock-out notices come into operation next week. It is estimated that the number of men who will be thus thrown out of work in the Manchester district is about 60,000. In the A.E.U. alone there are some 29,000 members, and of them only the men employed by the non-federated firms are still at work.

BARROW-IN-FURNESS, Thursday.

Pig Iron.

There are plenty of small orders being received for hematite pig iron, but none of them is for a large quantity; in fact, most customers are dealing in iron on the from hand-to-mouth principle. This will be the condition of trade until there is more confidence generally, and when there is an end of labour disputes. The price is right, and there is just the possibility that when trade does improve the cost per ton for mixed Bessemer numbers will increase. Small cargoes of pig iron are regularly being shipped for South Wales and the Continent, and there

is a probability of this side of business improving as time goes on. The consumption by local steel works accounts for a certain amount of iron smelted, but the tonnage varies from week to week.

Iron Ore.

There is no change in the local ore trade, which is only moderately employed, and this will be the case until trade takes a turn for the better. Here again there are hopeful signs concerning the future, and it is simply a case of waiting for the turn. Foreign ore is not yet arriving in any great quantities; in fact, for the past two months the importations have been light.

Steel.

The steel trade is weak, and the various mills are only spasmodically employed. There is nothing being done in ship-plates, and the rail trade is very dull indeed. The Barrow rail mill is working this week again, but there is no hope of a continuity of work. Other mills are off and on. Inquiries are few, and there are no signs of much activity for some time. The foundries are quiet. Shipbuilding and engineering are both under clouds at present, and vessels are being completed by apprentices slowly.

Strike Settled.

Following a conference at Furness Abbey on Tuesday with a sub-committee of the West Coast Ironmasters' Committee, a settlement was arrived at on the following day with the fitters who came out from the Barrow, Askham, Carnforth and Millom ironworks against the operation of the sliding scale, by which their wages were lower than the engineers' district rate. The terms of the agreement are, that the present basis of sliding scale shall be maintained, but in no case shall a member of the Amalgamated Engineering Union be paid less than the district rate operating in the district. If the scale falls below the district rate the difference of the amount over and above shall be carried forward as a debit, which shall be deducted from the men's earnings when the scale rises over and above the district rate. The men resume work at the various works on Monday. The trades unions are to get into touch with West Cumberland with a view to getting the whole of that area into the same agreement.

SHEFFIELD.

(From our own Correspondent.)

The Tardy Recovery.

The trade revival which has been so emphatically proclaimed in the daily Press still fails to make its appearance in Sheffield. The big works have reopened this week after the Easter holiday, but so far as I can gather the letter-boxes have not been bursting with orders, and the tell-tale records at the local Employment Exchange do not show any diminution in the number of unemployed. It is true that a few of the furnaces worked right through the holiday, but this was merely to complete certain urgent orders, and no significance can be attached to these isolated instances. The local steel trade, taken as a whole, has probably never been worse than it is to-day, and it may be taken that Sanderson Brothers and Newbould will not find themselves alone among steel makers in having to present an unsatisfactory report to their shareholders, such as this well-known concern circulated during the week. The majority of makers of high-grade steel are failing to meet expenses, and many of them are no doubt losing a considerable sum. The continuance of the engineering trade dispute, of course, aggravates this condition of things and postpones the recovery that most people feel would not be long delayed once a settlement with labour were reached. There has been an improvement in the export market for some time past and there is no lack of overseas inquiries, but most of them relate to the cheaper classes of steel, in which Sheffield's interest is limited. Local rolling mills are, however, getting some portion of this work. Hopes are also centred in the recovery of the coal industry, which would bring some orders to local makers of mining tools and appliances. There have also been received some orders for mining steel for South Africa. The railway orders for the home market are, however, still unrealised. The steel foundries are also extremely quiet with respect to marine work, and even the expectations of prosperity in connection with the motor car industry have not yet been realised to any considerable extent, though the recent big demand for light cars, motor cycles and cycles is beginning to show its effects in an increased demand for Sheffield steel and forgings and castings.

Official Optimism.

On the other hand, in contrast to the actual experience of the moment, as indicated in the preceding paragraph, a note of optimism is sounded in the new issue of the official *Journal* of the Sheffield Chamber of Commerce. "Foreign competition hardly counts just now," says the *Journal*; "We have still far to travel before we reach normal, but inquiries are certainly broadening out. There is a real shortage of pig iron on the Continent, and this is influencing our trade. Germany, still running at full speed, can only book very forward orders. France and Belgium seem unable to increase their production. In these circumstances what few urgent orders there are to give out are placed with British makers. Even the United States have inquired for some of our iron and steel, but too much importance must not be attached to the American coal strike; only half the miners are in the union and there are heavy stocks of coal on hand. Latin-American Republics are lively inquirers for steel products, but they desire very extended credits and only the 'poor, defeated Germans' are in a position to grant these. However, India will be a good buyer very shortly. Some of the small countries in Eastern Europe are also likely to prove good customers for railway and constructional steel. South Africa, Australia and New Zealand have some schemes well advanced which will call for quite considerable tonnages of our steel."

Big Engineering Combine.

Hopes are centred in the ambitious programme set out by the founders of the Power and Traction Finance Company, which has just been formed with a capital of a quarter of a million by five big firms in the steel and engineering industry—Cammell Laird and Co., John Brown and Co., Sir Wm. Arrol and Co., the English Electrical Company, and the North British Locomotive Company, together with the Prudential Assurance Company—with the declared objects to "carry on, finance, assist or participate in trading, financial, commercial, industrial, manufacturing, mining, and other businesses, works, contracts and undertakings . . . and as general engineers and contractors." Mr. W. L. Hichens, chairman of Cammell Laird and Co., and one of the directors of this new company, in an interview, said that it was to deal primarily with railway construction, including the building of the tracks and the supplying of locomotives, carriages and wagons, and all accessories. It will also undertake the erection of electrical generating stations, the electrification of railways, and schemes for making harbours and docks and everything required in connection with them. It is obvious that when such orders come along large amounts of steel materials will be required, and as John Brown and Co. and Cammell Laird and Co. are largely interested there is every reason to believe that Sheffield would in that event benefit largely. In many parts of the world, said Mr. Hichens, railways had fallen into disrepair, and there was a big field for work of this description in the future. Later on new railways would be required in new countries not yet opened up, and in many of these places there would be scope for a certain amount of electrification as well as for ordinary steam systems. Of course, other engineering work would follow wherever the railways went. With the strong financial interests represented by the Prudential Assurance Company, added Mr. Hichens, the group would be in a good position for dealing with the financial aspect of all contracts. It was widely felt that under modern conditions there was an important field for big groups which could undertake a comprehensive contract and carry it out completely, including the financial aspect.

Better News from Lincoln.

At Lincoln, where the engineering industry has been almost stagnant for many months past, a little more encouragement was given by the chairman of Clayton and Shuttleworth when addressing the shareholders on Monday. He said the most important development in the company's boiler works recently had been in connection with the making of water-tube boilers. A very important order had been placed with the company by the London County Council for three very large units and their accessories to be installed at Greenwich power station. Another London municipality had also within the last few days decided to adopt the company's patented boiler. It is of interest to note, as indicating the difficulties through which such companies have been passing, that this company has in one way or another had to provide during the last seven years a sum equal to the entire share capital of the company to meet exceptional war losses and the further losses inevitable in the circumstances of the last two years. The chairman of the company, Mr. P. W. Robson, immediately at the conclusion of the meeting of shareholders on Monday, hurried away to Genoa to attend the International Conference as an agricultural machinery expert. Mr. Robson is president of the Agricultural Engineers' Association.

Iron and Steel Trade Unification.

An important unification scheme in connection with the iron and steel trade organisations has been brought about by the formation of the Iron and Steel Trades Employers' Association. This consists of a merging of the four associations which have hitherto been carried on independently—the Midland Steel Rolling Mills Employers' Association, the Steel Ingot Makers' Association, the North of England Iron and Steel Manufacturers' Association, and the Scottish Steel Makers' Wages Association. For the purpose of organisation, administration, and for convenience in dealing quickly with matters of urgency, the area covered by the Association has been divided as follows:—(1) Scotland, (2) North-East Coast, (3) Midlands, South-West Yorkshire, Lincolnshire, and West of England. For the time being the headquarters will be at the Royal Exchange, Middlesbrough, with Mr. John A. Gregerson, secretary, Mr. L. Ennis, president, and Mr. Edward C. Craig, vice-president.

Fuel Position.

Colliery outputs are in excess of requirements for inland consumption, and firmer prices are ruling for export business. Industrial demands are, of course, still very meagre and steam coals are also accumulating. There are heavy stocks of small coal on hand at most collieries, and very low prices are quoted for inferior grades of slack. The output of coke, in spite of recent restriction, has sufficed to meet all demands. Following the closing of Newton-Chambers' Grange Colliery in the Rotherham area as a result of high rates, which was announced in this column last week, comes the news that on the other side of Sheffield the New Hucknall Company has posted notices intimating that in consequence of heavy losses made at two of the pits for some months past they will have to be closed unless the miners agree to some reduction before the end of the present week. This decision affects 2000 men.

Tools and Cutlery.

It is not alone the heavy engineering and steel trades that are in a stagnant condition. The lighter branches, including the tool trade—with certain exceptions, such as saws—are finding it difficult to meet foreign competition. Even Sheffield razors are reported by the Chamber of Commerce to be "a dead line," and the makers of pen and pocket knives have intimated that unless they can arrange a lower basis of cost they may have to close down entirely. Notices terminating engagements of spring knife makers will be given to-day (Friday) to take effect one month later. A new wage list has been put forward by the employers, and this will come into operation on the termination of the notices.

NORTH OF ENGLAND.

(From our own Correspondent.)

A Better Outlook.

The trade outlook is undoubtedly appreciably brighter, despite the disturbing influences of the labour troubles in the shipbuilding and engineering industries. There has not as yet been any marked revival of business after the holiday period, but there is a growing feeling in trade circles in the North of England that an early improvement may be looked for. This prediction applies chiefly to the iron and steel trades. At the present time there are twenty-nine blast-furnaces operating on the North-East Coast, and the output barely meets the demand, so that a revival in the trade would necessitate the starting of more furnaces, as there are scarcely any stocks to draw upon. A particularly encouraging feature is the marked improvement which has taken place recently in the export section of the iron trade. The demand continues on a large scale, and no diminution is looked for, as our prices are below those of French and Belgian producers, and although the margin is not great the tendency is for it to increase, as costs are rising on the Continent. It is true that British ironmasters are selling at a loss, but the recovery of the export trade justifies their policy, and it is hoped to wipe out, or at least reduce, the margin of loss when there comes into operation the reduction in the railway rates on raw materials and pig iron which has been promised as soon as the engineers' dispute ends.

Cleveland Iron Trade.

The Cleveland iron market presents few new features, but there is a general confidence that trade would rapidly expand if only a settlement of the engineering dispute can be speedily effected. There is no doubt that a good deal of business is being held up, particularly with Scotland. Fortunately, heavy shipments are still being made to the Continent, and there is still a fair business being done. Germany continues to buy Cleveland iron, and a few parcels are being sold to Italy, but for the Belgian trade there is very keen competition. To Scottish consumers No. 3 G.M.B. Cleveland pig iron is now quoted at 96s. 8d. f.o.t. Grangemouth, but to all other destinations the uniform quotations f.o.t. or f.o.b. are No. 1 and siliceous iron, 95s.; No. 3, 90s.; No. 4 foundry, 87s. 6d.; No. 4 forge, 85s.; and mottled and white iron, 80s.

Hematite Pig Iron.

Variations in the prices of East Coast hematite pig iron tend to hold up business. Latterly prices have been inclined to droop, and consequently consumers are not so keen to do business. It is suggested, therefore, that a stabilisation of prices would be all to the good of the trade. But the difficulty is that there is no "ring" to fix prices in the hematite trade, some of the makers preferring to compete in the open market, and whilst this may lead to fluctuations, it is certainly healthier than any arbitrary system of price fixation. The price of East Coast mixed numbers of hematite is put at 96s., with No. 1 at 97s., but some makers quote a little more.

Iron-making Materials.

The foreign ore trade is extremely quiet. The Bilbao strike has ended, and holders of best Rubio ore are anxious to realise their heavy stocks, but buyers decline to pay 27s. per ton, and as a consequence there is no business reported. Blast-furnace coke makers are also disinclined to cut prices, declaring that there is no margin of profit, and good medium Durham qualities remain firm at 28s. 6d. per ton delivered at the works.

Manufactured Iron and Steel.

There is no improvement in the manufactured iron and steel trade. The shipbuilding slump and the engineers' lock-out are factors which tend seriously to restrict the home demand. On the other hand, the prospect in the foreign trade is brightening, and British manufacturers seem to be in a more favourable position, owing to rising costs abroad. There is a fair demand for railway material, but works cannot get sufficient orders to operate continuously, and are simply working from hand to mouth. Prices, however, are very firm at the fixed home minima, and there is less disposition to cut for export.

The Coal Trade.

Quieter and easier conditions are noticeable in the Northern coal trade. There is, however, a fair number of large inquiries circulating from abroad, and some of them are likely to result in business being placed in this district. The placing of contracts by the Norwegian State Railways for 45,000 tons of best steams with Tyneside exporters, with deliveries in May and June, has excited much interest. The feature of the transaction is the great disparity in the prices paid, the whole having gone to Durham, with the exception of two cargoes of Broomhills, purchased at the low figure of 21s. 6d. f.o.b. On the other hand, Durham best steams made exceptionally high prices, including 10,000 tons of Lambtons and South Hettons at 26s. 2¼d. f.o.b.; 10,000 tons of Lambtons at 26s. 2d.; 7500 tons of South Hettons at 26s. 3d.; and 12,500 tons of Lambtons and South Hettons at 26s. 5¼d. f.o.b. The Swedish marine authorities have purchased 7500 tons of best screened steams for shipment before May 25th at 31s. 3d. per ton c.i.f., delivery at Carlskrona, or 31s. 5d. per ton c.i.f., with delivery at Stockholm. These prices are regarded as satisfactory and equivalent to the quotations at present ruling. The Danish State Railways are now actively in the market for 100,000 tons of best screened steams for delivery from May to the end

of December. There is likely to be keen competition for this order, not only among the Northern collieries, but from Scotland and other coal areas. There is some hope that eventually the bulk of the order will come to Northumberland, as this will represent new business, it will benefit the local steam coal trade considerably. Thus the outlook for the next few weeks is fairly bright for the prime brands of every class, but for baser sorts and smalls, prospects are not so well assured, and in a few cases the probabilities are that prices will fall. The coking coal section is a shade better, and for both unscreened and smalls the outlook is rather better at the moment. Bunkers are steady for beats and superiors, but secondary classes are appreciably easier. The coke market is steady with a moderately heavy demand for patent sorts, values being unaltered.

SCOTLAND.

(From our own Correspondent.)

All-round Depression.

THE unsettled industrial situation continues to dominate all markets, and general depression is still very evident. Producers frequently offer cheap prices to induce business, but buyers in general are taking little heed of such opportunities and almost nothing beyond absolute requirements changes hands. Foreign consumers, too, are fighting shy of a falling market, and export trade on the whole is of a meagre description.

Contract for Motherwell Firm.

Reports are just to hand of an important contract booked by the Motherwell Bridge Building Company. The order is for over 2000 tons of material and constructional work for India. This is the second foreign order of large dimensions that the Motherwell firm has secured within recent months. These contracts will enable the works to operate at full time throughout this year.

Pig Iron.

The Scotch pig iron makers still find difficulty in booking sufficient business to keep the furnaces going without adding to the stocks at the works. Only some twelve furnaces are in blast, but outputs are more than equal to the demand. Home requirements are small and export is lagging. Makers have been reducing the price of foundry qualities week by week, but quotations are a shade firmer again to-day. Hematite is unchanged. The usual weekly meeting of the Glasgow pig iron ring again passed off without any business being done. At the last meeting there were sellers of Scotch No. 3 G.M.B. at 97s. 6d. f.o.s. Glasgow, one month; Middlesbrough No. 3 at 90s. f.o.t. or f.o.b. Middlesbrough, one month; and mixed numbers East Coast nematite at 97s. 6d. f.o.t. or f.o.b. Middlesbrough.

Steel and Iron.

Stagnant conditions characterise the Scotch steel trade. The loss of engineering and shipyard orders, to say nothing of export business, is severely felt. Mills are only kept going with the utmost difficulty, and a large proportion of the plants is idle. Plates and sectional material are especially slow. Plates for export are round about £9 5s. per ton. The market for black and galvanised sheets is quiet. Home requirements are small and foreign demands are few. Prices for export are irregular and severely cut at times, competition for the small business passing being very keen. Bar iron makers have reaped little benefit from the last cut in prices. Orders are few and far between, and the works are very idle. The home demand is very slow and export is no better. Makers of tubes, light and heavy castings, and other descriptions of materials also report idle conditions.

Coal.

The Scotch coal trade generally remains dull and markets are weak. Dull industrial conditions restrict home demands to low limits and outputs are not easily disposed of. Railways, gasworks, &c., are only taking sufficient to maintain stocks at the requisite standards. Household coal is lagging and prices are gradually weakening. Shipping orders are very disappointing, inquiries from continental sources in particular having fallen off considerably. Orders on hand are being quickly worked off and prospects are not bright. Outputs are comparatively good, but with the accumulation of unsold coal an increase in idle time is likely. Conditions in Fifeshire and the Lothians are said to be a trifle brighter, but there is a big leeway to make up. Bunkering orders alone show any increase of late Despite the strike at Gawa, which affected loading at this side, shipments have been fair, but troubles in Denmark have cut off buying from that quarter. Aggregate shipments for the week amounted to 243,720 tons, against 222,780 in the preceding week and 346,755 tons in the same week in 1913.

Scottish Coal Reserves.

Speaking at the annual meeting of the Mining Institute of Scotland, on Saturday last, Mr Wallace Thorneycroft, the president, referred to the coal reserves of Scotland He said that in Lanarkshire the reserves of coal 18in. thick and upwards amounted to about eighty years' work at the present rate of output, and that something like one-fourth of these reserves were thin coals in the carboniferous limestone series of rocks, which were much disturbed by volcanic intrusions. Over one-third of the output of Scotland was raised in Lanarkshire, and as most of the seams ranging from 3ft. to 7ft. in thickness were exhausted, the problems of working thin seams at greater depths would increase in importance. In the remainder of Scotland, especially in Fife and the Lothians, the reserves were much greater, amounting in the aggregate to something like 600 years' work at the present rate of output.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Coal Trade Position.

ALL things considered, the position in the coal trade is very satisfactory, and prices are very well maintained at a level which was not thought possible a few months ago. In a general way, the inquiry coming along is not what can be described as brisk, but still coals are finding an outlet, which shows that the coals have been bought and therefore have to be shipped. Chartering continues on a fair scale, and during the second part of last week was quite active, so that the collieries have a moderately substantial amount of tonnage to come along to load, and should therefore be kept pretty busy. So far, there is no definite news concerning the placing of the order for 45,000 tons of coal for which tenders went in a week ago to the Norwegian State Railways. These coals are for delivery over May and June. From what information can be gleaned, it looks as if some firm had tendered for best Admiralty large, double-screened, on the basis of absolute cost price, but it remains to be seen whether even this procedure will bring the business to this district. It is interesting to note that the Danish State Railways are now in the market for about 75,000 tons of large steam coals for delivery from June 1st to the end of August, but here, again, the question is whether South Wales prices will compare favourably with those that will be put in from the Northern coal areas. Tenders for this inquiry have to be in on May 8th. Apart from this, there is no big order in the market, and at the moment interest centres in the operation of the new agreement respecting hours of working at the docks, and the effect it is going to have on the quicker turning round of tonnage and the improvement in the volume of shipments. The workmen have approved the new arrangement, which holds good for a period of three months. The first shift will be from 6 a.m. to 2.30 p.m., inclusive of half an hour for meal time, while the afternoon shift is from 2.30 to 11 p.m., including half an hour for meal time, so that there will be a clear eight hours' work in each of the two shifts, and it is the idea that the work shall be of an intensive character. If the work turns out as hoped, it is expected that shipments will be increased by 10 to 15 per cent., or equivalent to 70,000 to 80,000 tons per week at South Wales ports.

Labour Items.

Better work at the ports of shipment is all to the good, so far as the interests of the miners are concerned, as quicker loading means that delays and demurrage are avoided and a plentiful supply of wagons is forthcoming, and so the collieries are more likely to be able to work regularly. The fact that coal prices are being well upheld naturally gives hope that before long the miners' wage rate will be lifted above the minimum. The President of the South Wales Miners' Federation appears to be very confident that this will be the case in June, and it is to be hoped that he and the workmen will not be disappointed, as it will undoubtedly lead to a better feeling in the coalfield. There are matters which are causing some unrest among the workmen, and at a meeting of the Executive Council of the Federation on Monday last, the chief subject of discussion was the question of reinstatement of workmen in their former working places, further complaints having been received that employers are not carrying out the provisions of the national settlement in engaging men after the strike. The Council decided to convene a special delegate conference for May 8th to consider the continued refusal of some colliery owners to give preference of work to men formerly in their employment; irregular reductions in wages; and the methods to be adopted to increase the membership of the Federation; and the desire expressed for some alteration in the constitution of the Federation.

Tin-plate Trade.

The steel bar ascertainment for the past quarter of £7 1s. 10½d. does not affect tin-platers' wages, as their base rate is fixed at the equivalent of £7 10s. per ton for bars. There is no variation in the minimum price of £7 7s. 6d. per ton for sheet and tin bars, but the next quarter's ascertainment is fully expected to be higher than that just arrived at, as a new arrangement has been come to by which the price of £7 7s. 6d. is to be the minimum in South Wales and Monmouthshire, but outside this area the price is to be £7 15s. per ton. The tin-plate section of the Dockers' Union has just held its annual conference at Swansea to receive a review of the claims put forward from various departments in view of the forthcoming annual meeting of the Joint Industrial Council for the settlement of wages and conditions in the trade. There were sixty-eight items on the agenda relating to claims from the various departments, and all these were carefully considered. It is not expected that any drastic proposals will be put forward, in view of the fact that the improvement in the trade is so very gradual, but at the same time dissatisfaction does exist as regards the wages position.

Nickel for Tin-plates.

The question whether nickel can be substituted in place of tin for the coating of steel plates is causing a good deal of interest in this district, and it is stated that experiments to this end are being conducted at one of the largest tin-plate works in the Swansea district, which, if successful, will revolutionise the industry. It is stated that its chief importance lies in the simplicity of the amalgamation of the steel with the nickel, the joint product being subsequently rolled in the ordinary way. The process does away with the finishing department, but if the experiments are successful, the workpeople who are engaged in it would be found employment in the polishing of the plates. It is understood that a company has been formed to deal with the invention, under the style of the Steel Nickel Syndicate, of which a prominent member is Mr. Henry Mond, son of Sir Alfred Mond. It is stated that the process has "passed beyond the theoretical stage," and that it is largely a commercial question. At the present time nickel is slightly more expensive than tin, and consequently less nickel would have to be used to make it a paying proposition. There are those, however, who doubt whether nickel will supplant tin-plate manufacture, although it appears that nickel is a more durable metal. Tin-plates have held their own against the efforts of those to find a competing material, and many appear to be confident that this will continue to be the case. This was the opinion expressed at the meeting of the tin-plate section of the Dockers' Union held recently.

Current Business.

Firmness prevails in the steam coal trade, and as colliery companies are well sold for the remainder of this and the best part of next month, there is no reason to anticipate that the market will show much, if any, change from the conditions now prevailing. Best Admiralty large are quoted at 29s. and second qualities at 28s. 6d., while best smalls are practically unobtainable at less than 20s. Collieries have so many orders on their books that they see no reason to entertain anything less than these figures. The anthracite section is rather firmer, this being the case especially with sized coals and rubbly culm, while owners are steadfastly setting their faces against selling ahead, as they believe that even better prices will be obtainable with the continuance of the strike of the American miners.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

MESSRS. HORACE GREEN AND CO., whose head office and works are at Cononley, Keighley, have opened an office at Amberley House, Norfolk-street, London, W.C. 2, to deal with home and export business in London.

J. H. TUCKER AND CO., Limited, of Kings-road, Tyseley, Birmingham, ask us to state that on and from May 1st their London offices and stores will be removed from 217, Shaftesbury-avenue to 101, Dean-street, W. 1. Their telephone number will remain the same as hitherto, viz.:—3215 Gerrard.

MONOMETER MANUFACTURING COMPANY (1918), Limited, asks us to state that arrangements have been made for the manufacture of the Monometer furnaces for the whole of the United States, America, Canada, and South America by the Monarch Engineering and Manufacturing Company, 1206, American-building, Baltimore, Md., U.S.A.

THE CONSOLIDATED PNEUMATIC TOOL COMPANY, Limited, the London office of which is Egyptian House, 170, Piccadilly, W. 1, informs us that it has changed the address of its Bombay office to Amarchand Building (Block No. 1, First Floor), Ballard-road, Fort, Bombay.

INTERNATIONAL SCIENTIFIC CONGRESS AT LIEGE.—In our issue of February 10th we published a note in which it was stated that the Association des Ingénieurs Sortis de l'Ecole de Liége intended to celebrate the seventy-fifth anniversary of its foundation by holding a scientific congress at Liége from June 11th to 16th next. Owing, we believe, to the inability of the King of the Belgians to be present at the time originally fixed, it has now been decided to delay the date of the opening of the congress to June 18th. A detailed programme will be issued in due course.

LEEDS UNIVERSITY.—At a meeting of the Court of the University of Leeds, held on Wednesday, April 26th, it was decided to confer the following degrees, *honoris causa*, upon, among other persons:—D.Sc., Sir Dugald Clerk, F.R.S.; Sir Frank Watson Dyson, F.R.S., LL.D., Astronomer-Royal; Sir Richard Arman Gregory, F.R.A.S.; Sir Charles Scott Sherrington, President of the Royal Society, Waynflete Professor of Physiology in the University of Oxford; and LL.D., Mr. Benjamin Broadbent, M.A., of Lindley, Huddersfield; and Mr. Henry McLaren.

CROMPTON AND CO., LTD.—The annual general meeting of the Crompton Athletic Club was held in the Club House on Saturday last, April 22nd, Mr. J. Ankers presiding. The secretary, Mr. P. G. Cheverton, in presenting his report and statement of accounts, which were unanimously adopted, made special mention of the kindness of the directors in bearing the full liability of the Christmas tea and entertainment to the wives and children. Mr. T. Britten, manager and director, was unanimously re-elected president, and all the vice-presidents, with the addition of Mr. W. J. Freeland and Mr. H. Church, were elected. The hon. secretary, Mr. P. G. Cheverton, and the hon. treasurer, Mr. J. Barker, were also re-elected, as were Messrs. W. Crabb and F. Thompson, the hon. auditors.

FARADAY HOUSE ENTRANCE SCHOLARSHIPS.—As a result of the entrance scholarship examination held at Faraday House Electrical Engineering College on April 11th, 12th, and 13th, the following awards have been made:—R. W. Griffin, County School, Beckenham, the "Faraday" Scholarship of fifty guineas per annum, tenable for two years in college and one year in works; D. Moody, Central Foundation Boys' School, London, the "Maxwell" Scholarship of fifty guineas per annum, tenable for one year in college and one year in works; W. Swindells, Municipal Secondary School, Brighton, an Exhibition of thirty guineas per annum, tenable for two years; B. K. Watts, Aldenham School, an Exhibition of thirty guineas per annum, tenable for two years; J. W. Bailey, Elizabeth College, Guernsey, an Entrance Prize of twenty guineas; D. F. Gover, Dulwich College, an Entrance Prize of twenty guineas.

CONTRACTS.—The Underfeed Stoker Company, Limited, has recently received orders for travelling grate stokers for the Eastbourne, Marylebone, Wolverhampton, Stafford, Liége, and Cossipore (India) electricity undertakings, and for the Harworth Main Colliery, the Consett Ironworks, Scottish Oils, Limited, the Great Mountain Colliery, and Stockholm Gasworks; for Underfeed stokers from the Steel Company of Scotland and Messrs. Tate and Lyle; and for ash conveyors from the borough of St. Pancras and from the Philadelphia Colliery.—Wm. Johnson and Sons (Leeds) Limited, Castleton Foundry, Armley, Leeds, have been given an order for a large refractory brick and block-making plant for the Kailan Mining Administration of China. The plant will comprise about 150 tons of machinery, including grinding, mixing, automatic measuring, pugging and pressing plant. The contract has been obtained in keen competition with European and American manufacturers.—Ruston and Hornsby, Limited, of Lincoln, have, in face of world competition, been instructed by the Crown Agents for the Colonies to supply three exceptionally heavy railway type steam shovels to carry out the necessary excavations in rock for the new harbour at Takoradi, in Africa. These shovels are larger than any hitherto constructed in this country, the net weight of each being approximately 100 tons, bucket capacity 3¼ cubic yards, a full bucket representing 8 tons of rock, and they will have to work under especially onerous conditions.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. Coast—	
Native	38/-
(1) Spanish	28/-
(1) N. African	28/-
N.E. Coast—	
Native	—
Foreign (c.i.f.)	27/-

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) **Scotland—**		
Hematite	5 5 0	—
No. 1 Foundry	4 17 6	—
No. 3 ,,	4 12 6	—
N.E. Coast—		
Hematite Mixed Nos.	4 16 0	4 16 0
No. 1	4 17 0	4 17 0
Cleveland—		
No. 1	4 15 0	4 15 0
Silicious Iron	4 15 0	4 15 0
No. 3 G.M.B.	4 10 0	4 10 0
No. 4 Foundry	4 7 6	4 7 6
No. 4 Forge	4 5 0	4 5 0
Mottled	4 0 0	4 0 0
White	4 0 0	4 0 0
Midlands.		
(3) Staffs.—		
All-mine (Cold Blast)	13 0 0	—
Part Mine Forge	*None offering.*	
North Staffs. No. 3 F'dry	4 5 0 to 4 10 0	
(3) Northampton—		
Foundry Nos. 2 and 1	*Nominal.*	
,, No. 3	4 0 0	—
,, Forge	3 10 0 to 3 12 6	
(3) Derbyshire—		
No. 3 Foundry	4 2 6 to 4 5 0	
Forge	3 12 6 to 3 15 0	
(3) Lincolnshire—		
Basic	4 0 0 to 4 5 0	
Foundry	4 5 0 to 4 10 0	
Forge	4 2 6 to 4 5 0	
(4) N.W. Coast—		
N. Lancs. and Cum.		
Hematite Mixed Nos.	5 15 0	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
Scotland—		
Crown Bars	11 0 0	10 15 0
Best ,,	12 0 0	—
N.E. Coast—		
Common Bars	12 0 0	—
Tees	14 10 0	—
Lancs.—		
Crown Bars	11 10 0	—
Hoops	14 0 0	13 15 0
S. Yorks.—		
Crown Bars	12 0 0	—
Best ,,	13 0 0	—
Hoops	14 0 0	—
Midlands—		
Marked Bars (Staffs.)	13 10 0	—
Crown Bars	11 10 0	—
Nut and Bolt Bars	10 5 0 to 10 10 0	
Gas Tube Strip	11 10 0 to 11 15 0	
Hoops (*Nom.*)	14 0 0	—

STEEL.

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) **Scotland—**		
Boiler Plates	14 0 0	—
Ship Plates ⅜in. and up	10 10 0	—
Sections	10 0 0	—
Steel Sheets ⅛in. to ⅜in.	11 15 0	—
Sheets (Gal. Cor. 24 B.G.)	—	16 10 0

STEEL (*continued*)

	Home. £ s. d.	Export. £ s. d.
N.E. Coast—		
Ship Plates	10 10 0	—
Angles	10 0 0	—
Boiler Plates	14 10 0	—
Joists	10 10 0	—
Heavy Rails	9 10 0	—
Fish-plates	14 10 0	—
Channels	14 10 0	—
Hard Billets	9 5 0	—
Soft Billets	7 5 0	—
N.W. Coast—		
Barrow—		
Heavy Rails	9 10 0	—
Light ,,	11 0 0 to 13 0 0	
Billets	9 5 0	—
Ship Plates	10 10 0	—
Boiler ,,	14 10 0	—
Manchester—		
Bars (Round)	10 0 0 to 12 0 0	
,, (others)	11 0 0 to 12 0 0	
Hoops (Best)	15 5 0	15 0 0
,, (Soft Steel)	12 5 0	12 0 0
Plates	£10 to 12	10 0 0
,, (Lancs. Boiler)	16 0 0	—
Sheffield—		
Siemens Acid Billets	10 0 0 to 11 0 0	
Bessemer Billets	12 10 0	—
Hard Basic	9 5 0	—
Soft ,,	7 15 0	—
Hoops	12 5 0	—
Soft Wire Rods	11 0 0	—
Midlands—		
Small Rolled Bars	9 5 0 to 9 10 0	
Bessemer Billets	7 10 0 to 7 15 0	
Hoops	11 15 0 to 12 0 0	
Gas Tube Strip	10 5 0 to 10 10 0	
Sheets (24 W.G.)	11 10 0 to 12 0 0	
Galv. Sheets (f.o.b. L'pool)	16 0 0 to 16 5 0	
Angles	10 0 0	—
Joists	10 10 0	—
Tees	11 0 0	—
Bridge and Tank Plates	10 10 0	—

NON-FERROUS METALS.

Swansea—	
Tin-plates, I.C., 20 by 14	19/6 to 20/-
Block Tin (cash)	151 10 0
,, (three months)	153 0 0
Copper (cash)	59 0 0
,, (three months)	59 12 6
Spanish Lead (cash)	24 7 6
,, (three months)	23 15 0
Spelter (cash)	27 5 0
,, (three months)	27 2 6
Manchester—	
Copper, Best Selected Ingots	64 0 0
,, Electrolytic	66 0 0
,, Strong Sheets	88 0 0
,, Loco Tubes	0 1 1½
Brass Loco Tubes	0 0 11½
,, Condenser	0 1 2½
Lead, English	25 10 0
,, Foreign	24 10 0

FERRO ALLOYS,

(*All prices now nominal*).

	Per Ton.	Per Unit
Tungsten Metal Powder	1/6 per lb.	
Ferro Tungsten	1/4 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£27	10/-
,, 6 p.c. to 8 p.c. ,,	£26 10 0	9/-
,, 8 p.c. to 10 p.c. ,,	£25 10 0	8/-
,, Specially Refined		
Max. 2 p.c. carbon	£70	26/-
,, 1 p.c. ,,	£88	30/-
,, 0·75 p.c. carbon	£103	37/-
,, carbon free	2/- per lb.	
Metallic Chromium	5/3 per lb.	
Ferro Manganese (per ton)	£15 for home.	
,, Silicon, 45 p.c. to 50 p.c.	£18 0 0 scale 5/- per unit	
,, ,, 75 p.c.	£25 10 0 scale 6/- per unit	
,, Vanadium	20/- per lb.	
,, Molybdenum	7/- per lb.	
,, Titanium (carbon free)	1/3 per lb.	
Nickel (per ton)	£180	
Cobalt	14/- per lb.	
Aluminium (per ton)	£110 to £120 (British Official).	

FUELS.

	Export.
Scotland.	
Lanarkshire—	
(f.o.b. Glasgow)—Steam	20 6
,, ,, Ell	21/3
,, ,, Splint	21 6 to 24/6
,, ,, Trebles	20/-
,, ,, Doubles	18 6
,, ,, Singles	17/6
Ayrshire—	
(f.o.b. Ports)—Steam	20/-
,, ,, Splint	21/6
,, ,, Trebles	20/-
Fifeshire—	
(f.o.b. Methil or Burntisland)—Steam	18/- to 22/-
Screened Navigation	26/6
Trebles	20/-
Doubles	18/6
Singles	18/-
Lothians—	
(f.o.b. Leith)—Best Steam	20/-
Secondary Steam	19/6
Trebles	19/9
Doubles	18/6
Singles	18/-
England.	
(3) **N.W. Coast—**	
Steams	33/-
Household	40/- to 55/-
Coke	34/-
Northumberland—	
Best Steams	22/6 to 24/-
Second Steams	21/6 to 22/-
Steam Smalls	14/- to 15/
Unscreened	20/6
Household	25/- to 30/-
Durham—	
Best Gas	23/-
Second	21/- to 22/-
Household	25/- to 30/-
Foundry Coke	32/6 to 35/-
Sheffield—	Inland.
S. Yorks. Best Steam Hards	22/- to 23/- —
Derbyshire Hards	21/- to 22/- —
Seconds	20/- to 21/- —
Cobbles	20/- to 21/- —
Nuts	18/- to 19/- —
Washed Smalls	11/- to 12/- —
Best Hard Slacks	12/- to 13/- —
Seconds ,,	10/- to 11/- —
Soft Nutty ,,	9/- to 10/- —
Pea ,,	7/- to 8/- —
Small ,,	4/- to 5/- —
House, Branch	37/- to 30/- —
,, Best Silkstone	33/- to 34/- —
Blast Furnace Coke (Inland and Export)	19/- to 21/-	

Cardiff— (9) **South Wales.**	
Steam Coals:	
Best Smokeless Large	28/6 to 29/-
Second ,, ,,	28/- to 28/6
Best Dry Large	26/6 to 27/6
Ordinary Dry Large	25/- to 25/6
Best Black Vein Large	27/6 to 28/-
Western Valley ,,	27/- to 27/6
Best Eastern Valley Large	27/- to 27/6
Ordinary ,, ,,	24/6 to 25/6
Best Steam Smalls	19/6 to 20/-
Ordinary ,,	15/- to 19/-
Washed Nuts	27/6 to 30/-
No. 3 Rhondda Large	30/- to 32/6
,, ,, Smalls	19/6 to 20/-
No. 2 ,, Large	24/6 to 26/-
,, ,, Through	20/- to 22/-
,, ,, Smalls	16/6 to 18/
Coke (export)	30/- to 35/-
Patent Fuel	24/6 to 27/6
Pitwood (ex ship)	29/6 to 30/-
Swansea—	
Anthracite Coals:	
Best Large	37/6 to 40/-
Seconds	30/- to 35/-
Red Vein	28/- to 30/-
Big Vein	32/6 to 35/-
Machine-made Cobbles	47/6 to 50/-
Nuts	47/6 to 50/-
Beans	47/6 to 50/-
Peas	24/- to 26/-
Breaker Duff	10/- to 10/6
Rubbly Culm	16/- to 17/-
Steam Coals:	
Large	22/- to 24/-
Seconds	20/- to 22/6
Smalls	15/- to 18/-
Cargo Through	20/- to 21/-

(1) Delivered. (2) Net Makers' works. (3) At furnaces. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire and Ayrshire.

(6) Home Prices—All delivered Glasgow Station. Boiler Plates 10/- extra delivered England. (7) Export Prices—F.O.B. Glasgow.

(8) Except where otherwise indicated coals are per ton at pit for inland and f.o.b. for export and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b.

French Engineering Notes.

(From our Correspondent in Paris.)

Trade Expansion.

THE engineering trades are generally more active, and the slight and progressive improvement noticeable during the past month or two is only occasionally affected by outside influences. The amount of constructional work being carried out in the country is sufficient to provide fair employment, and in view of the vast programmes which are to be put in hand as soon as the necessary funds are available it is expected that the recovery will continue until it develops into a pronounced recovery, although the situation is still too uncertain to justify the hope that it will take place at an early date. The demand for structural material is good, and particularly active for electrical machinery, but there are many branches of the engineering trades that are badly in need of orders. Makers are therefore looking more and more to foreign markets, and they see with alarm that those markets are almost entirely closed to them, on account mainly of the fiscal policy which has provoked retaliation everywhere. While those trades which depend upon home requirements are insisting upon still higher import duties, others are clamouring for a more liberal policy and are complaining more particularly of the exactions of the French Government in its negotiations with Spain, Italy and other countries which will not accept the conditions imposed by the French as a basis for commercial arrangements. So long as the present difficulties exist the prospects of doing business abroad are very remote. The precariousness of the situation is observable in the returns of foreign trade during the first three months of the year, which reveal a large increase in the imports of raw material and a decline in the exports of manufactured goods. As the material and goods coming into the country are now valued according to the declarations of importers, while the exports are still based upon the official valuation, the figures do not provide an accurate means of comparison. In both cases there is a considerable shrinkage of values. According to these, the exports show an appreciable increase over imports. The weights, however, give a very different result, the imports being nearly three times as much as the exports, the total imports for the three months being 11,956,217 tons, an augmentation compared with the first quarter of last year of more than two million tons. By far the greatest increase was in raw material. The exports totalled 4,644,156 tons, an augmentation of 661,507 tons, due entirely to raw material. There was a decline of more than 100,000 tons in manufactured goods.

Rolling Stock.

One effect of the fiscal policy of this country is to keep up productive costs, because the higher import duties maintain the general standard of living costs, and wages and material do not decline in the same proportion as in countries where masters and men have both to make sacrifices in order to obtain foreign trade. For that reason manufacturers of railway material are unable to secure orders from abroad. The home railway companies are badly in need of rolling stock, but owing to their financial position they are obliged to defer buying, with the result that locomotive and wagon builders have little work at all. In all their attempts to secure contracts in South America they have been under-quoted by Belgian firms, and they accordingly see that their only opening is in Poland and Roumania, with which countries the French Government has entered into special commercial treaties. All the locomotive and wagon builders have therefore combined to organise a selling agency known as the Société Auxiliaire Française de Matériel de Chemins de Fer, which will sell or hire out rolling stock to those countries. The French firms hope that by grouping their interests in this way they will be able to secure the bulk of the considerable orders which Poland and Roumania will be obliged to distribute in the early future.

Rural Electrification.

At the time of the coal famine three years ago, when France had to pay exorbitant prices for imported fuel, a vast scheme was projected for supplying electricity to all the towns and rural districts, whereby it was hoped that the country would become practically independent of foreign supplies of fuel. The first proposal was to utilise the hydraulic power of the Rhone. The preliminary works are already being carried out, and the undertaking will be started upon as soon as the financial arrangements are completed. Since then much has been done in the way of putting down hydro-electric installations wherever water power is available. In the Midi, big schemes are under consideration. Wherever barrages can be built across rivers preparations are being made for the production of electrical energy. Co-operative societies are being formed everywhere to put down plants with State subsidies for the distribution of current, mainly for agricultural purposes, throughout the most remote rural districts. This electrical development has become so rapid that the Government has deemed it advisable to appoint an inter-ministerial Commission to prepare a programme for the electrification of the entire country. It is believed that by organising a general scheme it will be possible to avoid the mistakes and possible failures that will inevitably arise if scores, and even hundreds, of these undertakings should be carried out independently of each other. The schemes are falling under three heads, that is to say, the big hydro-electric enterprises which are utilising the water power of the Rhone and Dordogne, the Alps and Pyrenees; the small co-operative societies, composed mainly of agriculturists, who put down generating plants with State subsidies for distributing current locally; and companies which build generating stations in the colliery districts and distribute the current under a very high potential over a wide area, which current is supplied to co-operative societies that install their own transformers and mains for local distribution. Amongst the latter group are the big generating stations being constructed in the Nord and the Pas de Calais for distributing current under potentials of 45,000 and 90,000 volts. One line will connect Boulogne with Abbeville, a second Arras with Doullens, and a third Saint-Quentin with Chaulnes.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

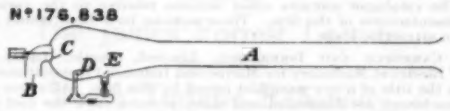
Copies of Specifications may be obtained at the Patent Office Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

INTERNAL COMBUSTION ENGINES.

176,838. November 5th, 1920.—GENERATING POWER BY COMBUSTION, D. McCrorie Shannon, 24, Village-road, Oxton, Birkenhead.

THIS is a long specification, and it describes a number of alternative arrangements, but the general principle is illustrated by the diagram. A is a vessel having a bulbous chamber at one end and open at the other. The explosive charge is taken in through tube B and valve C, which is held closed by a spring. The sparking plug is shown at D and is operated by the pressure acting on the piston E, which completes the electric circuit. The open end of the vessel may have an outlet of gradually increasing cross section, so as to give the gases at egress the most efficient velocity for propulsion. The combustion chamber is filled with an explosive mixture through the valve C. The charge is then fired, and as a result of the expansion the gases are propelled to the open end. The gases meet the atmosphere

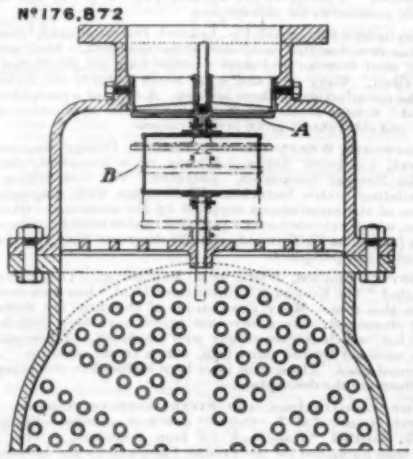


and the reaction propels the apparatus and the vessel to which it is attached. The sudden movement of the gases towards the outlet end creates a partial vacuum in the combustion chamber, the valve C then opens and admits a fresh charge. The remaining vacuum then causes the atmosphere to enter the open end of the chamber at a high velocity. The momentum of the moving column of air then compresses the charge in the combustion chamber. This compression pressure pushes piston E, which then makes the electrical contact, and causes sparking device to fire the charge. Thus oscillations are set up in the tube, which automatically cause a pulsating stream of gases to issue from the open end of the apparatus with a high velocity, and the entry of a fresh charge at the other end and the compressing and firing thereof, to maintain the oscillations.—*March 6th*, 1922.

CONDENSERS AND FEED-WATER HEATERS.

176,872. December 11th, 1920.—FEED-WATER HEATERS, Swan, Hunter and Wigham Richardson, Limited, Walker, Newcastle-on-Tyne, and S. R. Yates, 13, Queen's-gardens, Benton, Northumberland.

This invention relates to feed-water heaters of the surface type, and provides means by which in the event of a feed heater tube bursting, the steam supply pipe of the heater is automatically cut off, and any risk from the escape of water into the steam or outlet pipes and associated apparatus is avoided.

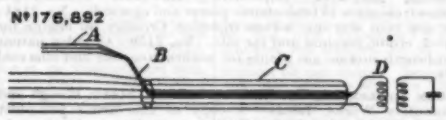


A chamber is arranged on the top of the heater and contains the steam inlet valve A, which is connected with the float B. In the event of a tube bursting, the water will raise the float and close the valve, thus preventing the water finding an outlet by the steam pipe. The heater is, of course, provided with a safety valve.—*March 13th*, 1922.

WIRELESS TELEGRAPHY.

176,892. December 15th, 1920.—IMPROVEMENTS IN WIRELESS TRANSMITTING STATIONS, Henry Joseph Round, of 9, Woodberry-crescent, Muswell Hill, London, N.

This invention relates to transmitting stations supplying aerials situated at a distance from the generator. The aerial tuning inductance is replaced by a trunk cable, which extends

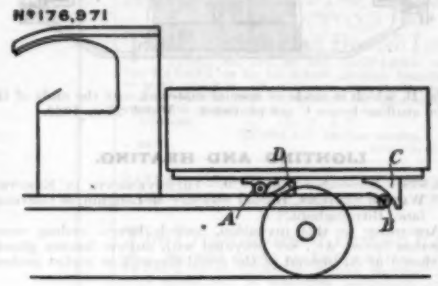


from the foot of the aerial to the generator or power-house, and the cable is shielded from the earth by a system of wires which are preferably arranged to surround the cable. A path is thus provided for the return current, which, together with the main or outgoing current, produce very little magnetic field, and losses are therefore avoided. In the drawing the aerial is shown at A, the cable at B, the wires surrounding the cable at C, and the transformer which forms the main oscillatory circuit in the power-house at D. A modification of the invention is also described.—*March 15th*, 1922.

MOTOR CARS AND ROAD TRAFFIC.

176,971. January 22nd, 1921.—TIPPING WAGONS, The Lacre Motor Car Company, Limited, Letchworth, Herts, and J. S. Drewry, 5, Baldock-road, Letchworth.

The object aimed at in this invention is to combine the tipping motion with the traversing motion in such a manner as to cause the centre of gravity of the moving load to traverse along a comparatively straight line, the mean of which line may form a gradual slope downwards in the direction in which the body is tipped. The body is supported by a pair of rollers

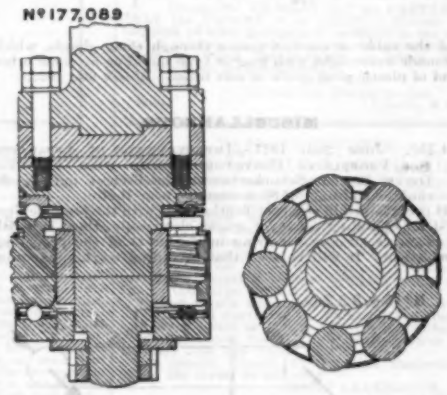


A, which run up curved plates D on the frame, and by other curved plates C, which bear on rollers B mounted at the rear of the frame. A slight variation in the formation of the shape of the plates can be made, whereby the position of the centre of gravity as the body is traversed can be made to follow either a slightly downward slope or a slight upward slope, but in any case the angle of the slope is approximately constant, with the result that very little force is required to operate the body.—*March 23rd*, 1922.

MACHINE TOOLS AND SHOP APPLIANCES.

177,089. May 17th, 1921.—FINISHING CYLINDER BORES, Wolseley Motors, Limited, Adderley Park, Birmingham, and E. Buswell.

A tool for finishing the interior surface of cylinders comprises a number of helically grooved rollers mounted in a cage round an arbor. The diameter of the arbor plus the diameters

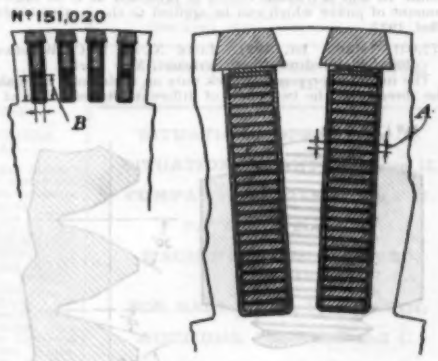


of two rollers is equal to the finished bore. The tool is forced into the cylinder, and as it rotates the grooves of the rollers make a fine cut, while the plain portions roll out any irregularity of the surface.—*March 23rd*, 1922.

DYNAMOS AND MOTORS.

151,020. September 15th, 1920.—ROTATING FIELD MAGNETS FOR HIGH-SPEED ELECTRIC MACHINES, Max Gruber, of 2, Route de Chene, Geneva, Switzerland.

According to this invention, the cooling of the machine is improved by distributing the magnet winding over a much larger number of slots than is usual. The orthodox and improved methods of winding the rotor are shown by the right



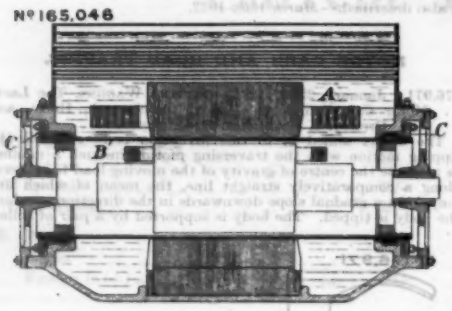
and left-hand drawings respectively, the small cooling surface for the conductors in the former case being shown at A and the increased cooling surface in the latter instance at B. There are four other illustrations.—*March 5th*, 1922.

165,046. June 17th, 1921.—IMPROVEMENTS IN OR RELATING TO ROTARY HIGH-TENSION ELECTRICAL MACHINES WITH AN OIL BATH, Kulman Kundó, of 46, Rozsa-utca, Budapest, Hungary.

The stator of a high-tension machine constructed in accord-

ance with this invention is immersed in an oil bath A, whilst the rotor runs free in air. The oil chamber is separated from the part of the machine occupied by the rotor by a cylindrical

No 165,046



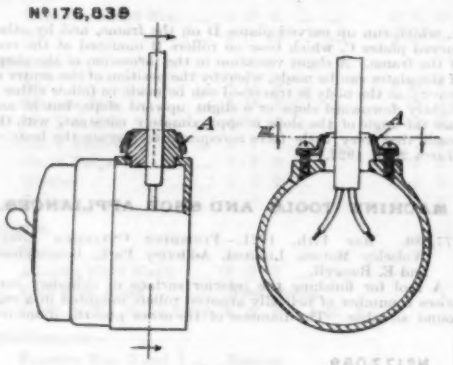
tube B, which is made of special material. At the ends of the tube stuffing-boxes C are provided.—*March 23rd*, 1922.

LIGHTING AND HEATING.

176,839. November 5th, 1920.—Improvements in Electric Wiring Systems, Harold Fletcher McLoughin, of Garrison-lane, Birmingham.

According to this invention, switch boxes, ceiling roses, junction boxes, &c., are provided with outlets having glands, as shown at A, instead of the usual screwed or socket outlets,

No 176,839



and the cable or conduit passes through these glands, which are made water-tight with lead or type metal or by some other kind of plastic alloy, such as soft brass.—*March 6th*, 1922.

MISCELLANEOUS.

164,332. June 2nd, 1921.—Improvements in Apparatus for Propelling Conveyor Trucks with Electric Drive, Siemens-Schuckertwerke Gesellschaft mit Beschränkter Haftung, of Siemensstadt, near Berlin.

It is explained in this specification that with the usual devices used for operating conveyor trucks electrically, there is a risk of excessive stresses occurring in the parts of the propelling mechanism. It will be seen that according to this invention

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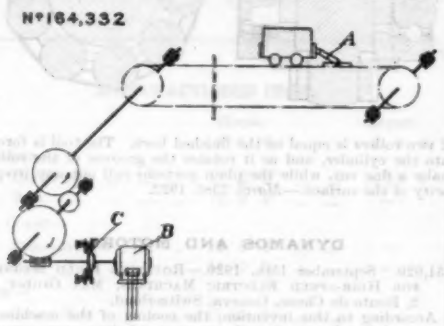
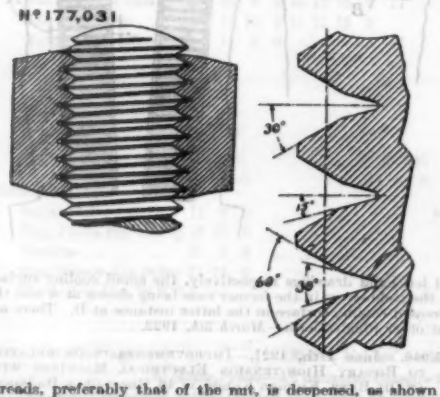


the drive A, which propels the trucks, is connected with an endless band, driven through a train of gearing by the electric motor B, and a friction clutch is provided at C to limit the amount of power which can be applied to the system.—*March 23rd*, 1922.

177,031. March 1st, 1921.—Lock Nuts, I. C. Woodward, 306, South Salina-street, Syracuse, New York.

The inventor proposes to lock nuts on their bolts by making the threads on the two parts of different pitches. One of the

No 177,031



threads, preferably that of the nut, is deepened, as shown in the detail, so that its turns can yield in an axial direction to accommodate the difference of pitch.—*March 23rd*, 1922.

Catalogues.

John M'Dowall and Sons, Johnstone, Glasgow.—A copy of leaflet R.K., illustrating the "Clyde" deck caulking machine.

John Hands and Sons, Limited, Cardigan Works, Belmont-row, Birmingham.—We have received a copy of the firm's new standard stock list of power presses.

Thomas Broadbent and Sons, Limited, Huddersfield.—Illustrated folder of automatic centrifugal clutches for alternating-current or direct-current motors.

W. Canning and Co., Limited, 133-137, Great Hampton-street, Birmingham.—A copy of pamphlet entitled "Prevention of Rust by Ajax Cold Electro-galvanising Process."

British Insulated and Helsby Cables, Limited, Prescot, Lancs.—Pamphlet No. P172 illustrates and describes "Prescot Meters." Parts of these meters are illustrated in sectional drawings.

General Electric Company, Limited, Magnet House, Kingsway, W.C. 2.—A copy of leaflet No. L 2713. A revised catalogue prices of Witton primary cells and parts appearing in L 2 section of 1920 edition catalogue.

Fraser and Chalmers Engineering Works, Erith, Kent.—A copy of pamphlet No. F. and C. 2637. Bulletin No. 13B illustrates and describes Fraser and Chalmers steam turbines, single-stage impulse type for small outputs.

Electro Metals, Limited, 50, Kingsway, W.C. 2.—A copy of leaflet No. 1001 has been received. Electric steel furnaces are discussed and illustrated, and much useful information has been collected and embodied in the present pamphlet.

Thompson and Southwick, Limited, Tamworth, Staffs.—Illustrated catalogue of sizes and particulars of pit head pulleys. The catalogue contains other sections relative to the varied manufactures of the firm. These sections have been bound in an attractive cover.

Campbell and Isherwood, Limited, Bootle, Lancs.—"Electrical Machinery for Marine and Industrial Installations" is the title of a new pamphlet issued by this firm. All types of machinery are illustrated and many pictures show the tool or apparatus in operation.

Engineering Supplies, Limited, 11, Queen Victoria-street, E.C. 4.—A copy of the new steam flow meter pamphlet has been received. A diagram of the meter is embodied in a description of the apparatus. In addition to this, the price of different sizes and types is given.

British Mills Foundry, Cornwall-road, Smethwick, Birmingham.—Booklet No. 18 embraces "Malleable Castings." In addition to the production of malleable castings being described, the chemical and physical characteristics are discussed, and some micrographs are reproduced.

Babcock and Wilcox, Limited, 30, Farringdon-street, E.C. 4.—A copy of a new pamphlet, entitled "Steam Generation." Besides a good deal of material of a technical nature, the book is fully illustrated with pictures and diagrams. The pamphlet is only a brief summary of the firm's principal manufactures. Each section is dealt with more fully in separate catalogues.

Darracq Motor Engineering Company, Limited, The Vale, Acton, W. 3, and 150, New Bond-street, W. 1.—An exceptionally well produced brochure setting forth the merits of the Talbot-Darracq cars. Illustrations of the different types of car are shown, together with a specification of each one. A view of different stages of manufacture of coachwork has been embodied in a composite page.

Gwynne's Engineering Company, Limited, Hammersmith Ironworks, London, W. 6.—Pamphlet No. 85 on Gwynnes' "Invincible" salvage pumping machinery. Besides containing a specification of standard open and enclosed type engines for salvage pumps, many illustrations of pumps under work are embodied. A complete list of spare parts is given, and also a list of accessories for salvage sets.

Frederick Braby and Co., Limited, Petershill-road, Glasgow.—This firm has just published three new lists. Steel storage bins, steel barrows and steel weather bars are illustrated and described. Many new and quite novel features are embodied in the manufacture of these articles. A copy of a pamphlet, entitled "Eclipse Roofs and Sidelights." The application of the roof and sidelights is given in illustrations.

Cleworth, Wheal and Co., Limited, Grange Engineering Works, Castleton, Lancs.—A copy of a pamphlet, entitled "The Natural Humidifier," patented. For humidifying and ventilating textile factories. Illustrations with diagrams are given of the installations supplied by the company. Observations, which extended over a period of twelve months, were made in a factory at Hollinwood, and the diagrams have been reproduced in this pamphlet.

Royles, Limited, Irlam, near Manchester.—The pamphlet entitled "The Economic Utilisation of Heat," has been received from this firm. Many productions of this firm are described and illustrated. We notice that prices have been included in this list, which is exceedingly well produced. A pamphlet is also enclosed by the same firm, which treats with the "Auto Thermal Feed." Diagrams have been included in this pamphlet to illustrate the description.

The Frodair Iron and Steel Company, Limited, Fenchurch House, E.C. 3.—Copy of new and enlarged edition of a book, entitled "Handbook for Iron Founders." This book has been published for the Frodair Company by the Locomotive Publishing Company, Limited, 3, Amen-corner, E.C. 4, and contains a great amount of very useful and necessary information to a would-be successful foundryman. Results obtained from long experience have been collected and reproduced in book form.

Fuller's United Electric Works, Limited, Chadwell Heath, E.—This company has now a fully equipped factory to deal with ebonite manufacture. Competition with the continental manufacturers in ebonite moulding no longer holds any terror to this firm. List No. 150A deals briefly with the many mouldings which can be supplied at the present time. Views taken in the works are reproduced, and an ebonite calendar has been received from Messrs. Fuller's, which was manufactured in their works, and is of very neat design.

Crossley Brothers, Limited, Openshaw, Manchester.—The following illustrated lists have been received from this firm:—No. 2177A: The new Crossley small town's gas engines. No. 2199: The new Crossley small oil engines for paraffin or kerosene. No. 2192: Superseding No. 2146. Crossley gas engines from sizes 15 brake horse-power and upwards. No. 2184: The new cold starting, airless injection Crossley oil engine for refined, crude, residual and tar oils. No. 2159: Crossley patent open-hearth suction gas plants for anthracite, coke and charcoal fuels.

John Fowler and Co. (Leeds), Limited, Steam Plough and Locomotive Works, Leeds.—A copy of this firm's pamphlet on subsoil cable ploughs for English agriculture. At the subsoiling demonstration of the County of Southampton Farm Institute, held at Sparsholt, Winchester, on March 27th and 28th, a Fowler steam cable tackle was demonstrated. It comprised a pair of Fowler's latest compound ploughing engines and a 4-5-furrow combined topsoil and subsoil plough. The pamphlet contains a description of these machines. Several views of machines on different grades of work are also shown.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

Institution of Electrical Engineers: Scottish Centre.—The Technical Institute, Dundee. Paper: "Single and Three-phase Alternating-current Commutator Motors with Series and Shunt Characteristics," by Professor S. Parker Smith. 7.30 p.m.

Institution of Aeronautical Engineers.—The Engineers' Club, Coventry-street, W. 1. Paper, "Some Unsettled Problems of Aeroplane Design," by Captain Sayers. 6 p.m.

Institution of Mechanical Engineers.—Storey's-gate, Westminster, S.W. 1. "An Account of Some Experiments on the Action of Cutting Tools," by Professor E. G. Coker and Mr. K. C. Chakko, D.Sc. 6 p.m.

Royal Institution of Great Britain.—Albemarle-street, Piccadilly, W. 1. Discourse, "Vitamine Problems," by Mr. Arthur Harden, D.Sc. 9 p.m.

Royal Aeronautical Society.—7, Albemarle-street, W. 1. Paper, "Some Notes on Commercial Aircraft," by Mr. S. H. Evans. 6.45 p.m.

North-East Coast Institution of Engineers and Shipbuilders.—Bolbec Hall, Newcastle-on-Tyne. Paper, "Corrosion, with Special Reference to the Ferrous Metals and the Deterioration of Ships," by Mr. A. Pickworth, M.Sc. 7.30 p.m.

The Junior Institution of Engineers.—Caxton Hall, S.W. 1. Lecturette: "Some Notes on the Utilisation of Water Power," by Captain H. Whittaker. 8 p.m.

The Institute of Metals: Sheffield Local Section.—The University, St. George's-square, Sheffield. Paper: "Why Non-Ferrous Metals Crack," by Dr. W. H. Hatfield. 7.30 p.m.

SATURDAY, APRIL 29TH.

The Institution of Municipal and County Engineers.—Eastern District Meeting of the Institution will be held at Chiswick. 10.30 a.m.

MONDAY, MAY 1ST.

The Society of Engineers.—Burlington House, Piccadilly, W. 1. Paper. "The Testing of Small Electrical Plant," by Dr. C. V. Drysdale. 5.30 p.m.

TUESDAY, MAY 2ND.

Institution of Civil Engineers.—Great George-street, Westminster, S.W. 1. Lecture, "Some Post-war Problems of Transport," by Sir John Audley Frederick Aspinall. 6 p.m.

WEDNESDAY, MAY 3RD.

Institute of Metals.—Institution of Mechanical Engineers, Storey's-gate, Westminster, S.W. 1. General meeting. The twelfth annual May lecture on "The Relation of the Elements," by Professor Sir Ernest Rutherford, F.R.S. 8 p.m.

Institution of Electrical Engineers.—Savoy-place, Victoria Embankment, W.C. 2. Wireless Section Meeting. "Short-wave Directional Wireless," by Mr. C. S. Franklin. 6 p.m.

THURSDAY, MAY 4TH.

Iron and Steel Institute.—Connaught Rooms, Great Queen-street, London, W.C. Annual dinner. 7 for 7.30 p.m.

The Institution of Locomotive Engineers (London).—Engineers' Club, 39, Coventry-street, W. 1. Paper, "Comparison between Superheated and Non-superheated Tank Engines," by Mr. J. A. Hookham. 7.15 p.m.

Association of Railway Companies' Signal Superintendents and Signal Engineers.—Railway Clearing House, London. Sixty-fourth Conference.

THURSDAY AND FRIDAY, MAY 4TH AND 5TH.

Iron and Steel Institute.—Institution of Civil Engineers, Great George-street, S.W. 1. Annual meeting.

FRIDAY, MAY 5TH.

Institution of Mechanical Engineers.—Storey's-gate, St. James's Park, S.W. 1. Informal meeting. Subject, "Failures." 7 p.m.

SATURDAY, MAY 6TH.

Royal Aeronautical Society.—Visit to the De Havilland Aircraft Works, Edgware. Meet at works, 10 a.m.

The Association of Engineers-in-Charge.—St. Bride's Institute, Bride-lane, E.C. 4. Discussion, "Uniflow *versus* Multiple-expansion Steam Engines." 7.30 p.m.

WEDNESDAY, MAY 10TH.

Institution of Automobile Engineers.—Institution of Mechanical Engineers, Storey's-gate, S.W. 1. Paper: "Automobile Calculations: Practical Methods for the Designer," by Mr. James Watt. 8 p.m.

WEDNESDAY, MAY 17TH.

Institution of Automobile Engineers: North of England Centre.—Y.M.C.A. Hall, Albion-place, Albion-street, Leeds. Paper: "Experiments on Cams and Poppet Valves," by Professor G. F. Scholes. 7.30 p.m.

TUESDAY, MAY 30TH, TO FRIDAY, JUNE 2ND.

Institution of Electrical Engineers.—Summer Meeting in Scotland. Ladies invited. For programme, see page 326.

Engineering Golfing Society.—The spring meeting of the Engineering Golfing Society will be held at West Hill, Brookwood, Surrey, on Wednesday, May 10th. The following programme has been arranged:—Morning: The "President's Challenge Cup," presented by Sir Alexander Kennedy, for members in the First Division, with handicaps of 10 and under, eighteen holes stroke competition under handicap; the "Wilson Challenge Cup," presented by Mr. R. P. Wilson, for members in the Second Division, with handicaps of 11 and over, eighteen holes stroke competition under handicap. A memento and a second prize will be given in each division. There will also be a prize for the best scratch score, presented by the Captain, Mr. K. A. Wolfe Barry. Afternoon: Four-ball foursomes match play against bogey, eighteen-hole round. There will be two first and two second prizes for this competition. The entries close first post on Thursday, May 4th. It is also proposed to hold during the coming season a match play tournament under handicap on lines similar to those of former years. Entries for it, also, close on May 4th. Further particulars concerning it and the spring meeting may be obtained on application to the honorary secretary, Mr. Walter L. Mansergh, 5, Victoria-street, Westminster, S.W. 1.